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INDIAN AGRICULTURAL  
RESEARCH INSTITUTE, NEW DELHI.

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**GOVERNMENT OF INDIA**  
**CENTRAL BOARD OF IRRIGATION**

**QUARTERLY BULLETIN**  
**No. 5**

**JANUARY TO MARCH 1937.**

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**SIMLA,**  
**15th April 1937.**

**PRESIDENT**

**1936-37.**



**Mr. G. M. ROSS, I.S.E., Chief Engineer and Secretary to Government,  
P. W. D., North-West Frontier Province.**

Office of the Secretary,  
Central Board of Irrigation,  
Simla, H. O.

## **QUARTERLY BULLETIN No. 5.**

JANUARY To MARCH 1937.

*Correction.*—The description of the Causeway over the Badgani Creek on the Karwar-Madras, Frontier Road, on page 13 of Bulletin No. 4 was inadvertently placed under “Madras”. This work is in the Bombay Presidency.

### **The Board.**

Mr. C. C. Mackintosh, Chief Engineer, P. W. D., Irrigation Branch, Burma, proceeded on leave in February and his position on the Board is now occupied by Mr. A. A. H. Ricketts.

Mr. T. B. Tate, C.S.I., Chief Engineer and Secretary to Government, Punjab, P. W. D., Irrigation Branch, proceeded on leave preparatory to retirement at the end of March, and Mr. S. H. Bigsby, C.I.E., has been appointed Chief Engineer in the vacancy and becomes a Member of the Board.

NOTE.—Secretary would be glad to receive information regarding changes in the Membership of the Board as soon as they are contemplated or effected.

### **Research Committee.**

An informal meeting of the Research Officers was held in Lahore from the 18th to 20th February 1937 on the occasion of the annual meeting of the Punjab Engineering Congress. The following officers attended :—

Mr. G. M. Ross, President of the Board.

Mr. Gerald Lacey, Superintending Engineer, United Provinces.

Mr. W. E. Bushby, Research Officer, Sind.

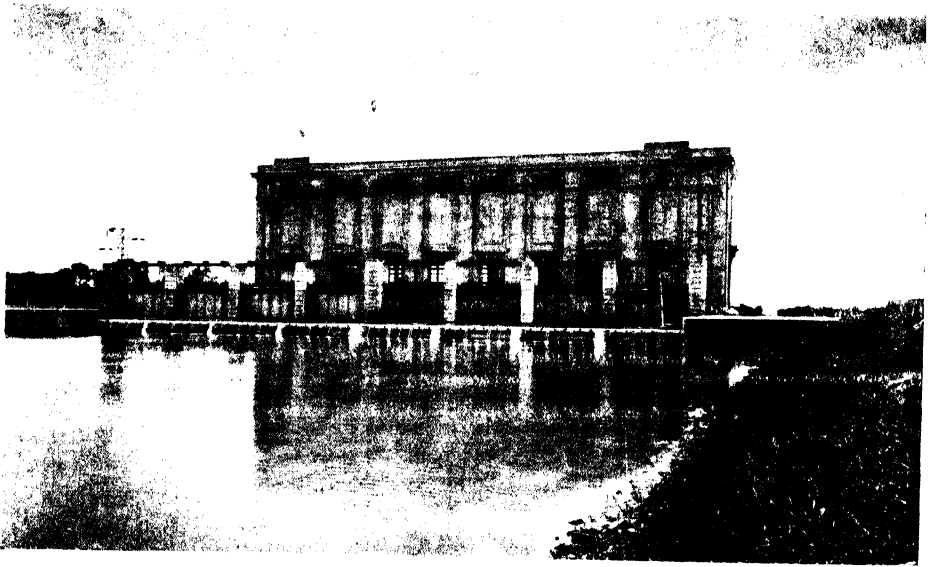
Mr. A. R. B. Edgecombe, Research Officer, United Provinces.

Mr. A. R. Thomas, Research Officer, Bombay.

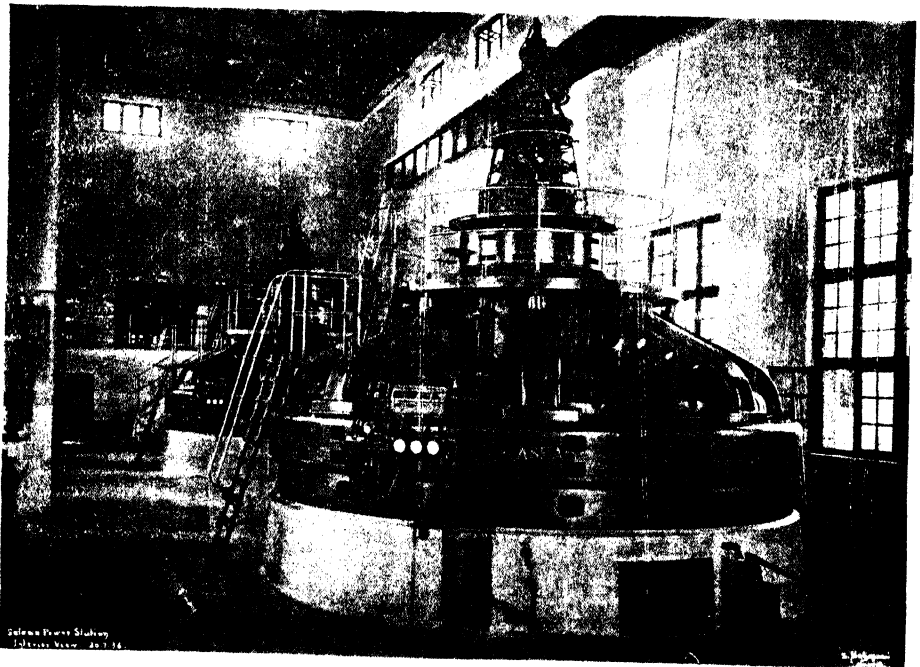
Mr. M. T. Gibling, Secretary, Central Board of Irrigation.

Dr. E. McKenzie-Taylor, Director, Punjab Irrigation Research Institute, Lahore, very kindly invited the Research Officers to visit the Institute, and the Honorary Secretary, Punjab Engineering Congress, extended an invitation on behalf of the Congress, to the Research Officers to attend the Annual Meeting of the Congress which was held from the 18th to 20th February. Both invitations were gratefully accepted.

**GANGES HYDRO-ELECTRIC GRID SCHEME. SALAWA  
POWER STATION.**



**Upstream View.**



**Interior View of the Power Station.**

- (d) The programme of research work to be carried out during the ensuing year.
- (e) The question of the next cold weather informal meeting of the Research Officers.

### Board Publications.

The revised edition of the "Glossary" (Publication No. 5) is still under preparation as replies are still awaited from some officers.

"Design of Weirs on Permeable Foundations" (Publication No. 12) is in the press, and will be distributed shortly.

"Annual Report (Technical) of the Work of the Central Board of Irrigation for 1935-36" is in the press.

The "Waterlogging Questionnaire", the title of which was changed by the Board to "Questionnaire on conditions predisposing to harmful soil saturation which may ultimately result in waterlogging" has been printed up and distributed to Members and a few other officers. It will again be discussed at the next Annual Meeting of the Research Committee and of the Board.

The Questionnaire on "Land Reclamation" with Dr. McKenzie-Taylor's replies, and remarks thereon by certain officers, is in the press. This will be discussed at the next meetings of the Research Committee and the Board.

It is hoped that Mr. Gerald Lacey's publication on his theory of the design of channels in alluvium will be produced during the year.

### Works Section.

#### UNITED PROVINCES.

##### *Salawa Power Station.*

The four photographs on the opposite page are of the Salawa Power Station which has been built on a by-pass from the Ganges Canal at Salawa, and forms one of the generating units of the Ganges Hydro-electric Grid. The Station is designed to give a continuous output of 3,000 K.W. by means of two turbo-alternators operating on a head of 15 ft. An interesting feature of this installation is the four automatic weir gates, two of which (25' span) are on the main canal fall, and the others (40' span) on the downstream side of the Power House on the by-pass. The latter can be seen on the first photograph reproduced. These gates permit a regulated quantity of water to pass, either through the turbines or over the weir or both, depending on the load, and are entirely automatic. The adjustable eccentric pulleys taking the counter weight ropes allow for fine adjustment, and the gates are said to be very successful. (Details of these gates are available in the office of the Central Board of Irrigation).

## SIND.

*Combined Regulator and Escape at the extreme tail of the Baghar Inundation Canal.*

A combined regulator and escape is in course of construction at the extreme tail of the Baghar Inundation Canal at its junction with a sea creek at the mouth of the Indus River.

As it is a flume design with a very high velocity at the throat and the bed downstream is at sea level, a complete model was first made of all conditions likely to be met with. A maximum of 4,800 cusecs is likely to be passed down to the sea, and with the introduction of a baffled cistern in continuation of the downstream glacis the probable bed velocity is reduced to a non scouring one.

The regulator is expected to be in operation in June 1937.

## BOMBAY.

*Special Repairs to Gol Gumbaz at Bijapur.*

The Gol Gumbaz, the tomb of Sultan Mahomed (1626-56) is famous for its magnificent dome, the exterior diameter of which is 144 ft. while that of the interior is 124 ft. 5 inches. The dome had been leaking at several places for many years past. In the year 1890 when patches of weak concrete and plaster peeled off from the inner side and cracks on the outer side of the dome were noticed, extensive repairs consisting of rendering the surface partly in cement and partly in lime mortar were carried out. In spite of these repairs the process of the formation of cracks continued : to a lesser extent however. In 1916 attention was again directed to these cracks and the consequent dampness, when steps were taken to set them right. In 1922 cracks appeared on the surface of the dome and when treated with a thin coat of plaster were later found to widen. Dampness also appeared on the inner side of the dome and patches of plaster began to peel off. Repairs to these cracks were started in 1924 and finished in 1931. These repairs mainly consisted of filling the cracks and removing the loose plaster, and other minor items. In spite of this, dampness was still present and fresh cracks also appeared. On the inner side of the dome large patches of plaster which had become loose, fell.

The problem as to how to repair and protect this famous dome from further decay, was very complex. Various methods of repair were thought of and many estimates prepared. Ultimately it was decided to cover the whole of the outside of the dome with reinforced gunite and to provide hooping reinforcement both at the base of the dome, and at its plane of rupture.

The work was carried out between August 1936 and January 1937 at a cost of Rs. 69,000.

Briefly, the work consisted of encircling the dome at its base and also at its plane of rupture with 4 bars each of  $1\frac{1}{4}$ " diameter spaced 1'-3" apart and the entire dome further reinforced with B. R. C. Fabric and covered with gunite to a minimum thickness of two inches. "Gunite" is a trade term applied to a patented process which consists of applying a mixture of cement and sand to a surface at a pressure of some 50 lbs. per sq. inch by means of a cement gun.

### Information Bureau and Library.

The following are some of the enquiries dealt with during the quarter under review :—

Information regarding irrigation projects in India.

The design of meter flumes.

Automatic gates for a weir.

Slips in earthen dams.

A river training problem.

Lacey's theory on the design of channels.

Hydraulic rams.

The problem of weed eradication from canals is one which concerns a number of irrigation engineers in this and other countries. An investigation is to be carried out by the Council for Scientific and Industrial Research, Australia, who have enquired for information from this country. Members of the Board have been addressed on the subject and it is hoped that all available information will be supplied. Considerable difficulty is experienced with weeds in Orissa in the low velocity navigation canals. The weeds become troublesome between January and March and unless cutting is done from October onwards, the growth gets too thick for the use of weed cutting implements. The present expedient is to run the canal almost dry for ten days and clear up the weeds in the head reaches by hand labour. Coolies wade in the canal bed in a row, pull up the weed by hand, and roll it along like a blanket and throw it on the bank. As there is not much demand for rabi irrigation, canals can be closed once for ten days after warning navigation, without causing any trouble. Closing the canals several times for sun drying and killing the weeds is not practicable as it takes too long for the water to drain out and the weeds to dry off, and irrigation suffers. Experiments are being carried out with weed cutting appliances which may be attached to a steam launch.

Copies of the Questionnaire on " Meandering of Rivers " as framed by Mr. Mazumdar, Superintending Engineer, Bengal, and accepted by the Board at their last annual meeting, have been distributed to Members of the Board with a request for information on any of the points raised in the Questionnaire. The Railway Board has also been supplied with copies with a similar request.

### MISCELLANEOUS.

The Government of India have agreed to finance the Hydrodynamic Research Station, Khadakvasla (Poona), for the year 1937-38, and Mr. C. C. Inglis, C.I.E., Superintending Engineer, Bombay, has taken charge as Director from the 1st April 1937 on return from leave. Members of the Board have been asked to submit problems for investigation at the Station during this year.

His Excellency the Viceroy recently made a motor car tour through some of the western districts in the United Provinces and visited the U. P. Government's vast network of electrical projects for the development of rural areas. This electrical network forms part of the Ganges Canal Hydro-electric Grid and State Tube Well Irrigation Scheme.



The following officers of the Irrigation Departments received honours on last New Year's Day :—

Mr. F. ANDERSON, C.I.E., Chief Engineer, P. W. D., Irrigation Branch, United Provinces. (President of the Board from November 1935 to July 1936).	C. S. I.
Mr. T. B. TATE, Chief Engineer and Secretary to Government, Punjab P. W. D., Irrigation Branch. (President of the Board from July 1936 to November 1936).	C. S. I.
Mr. E. W. D. JACKSON, Executive Engineer (Irrigation), Burma.	O. B. E.
Mr. ROBERT MCINTOSH, Executive Engineer, P. W. D., Madras.	M. B. E.
Sheikh MOHAMMAD NIAZ, Assistant Engineer, Punjab P. W. D., deputed as Executive Engineer, Bahawalpur State.	Khan Bahadur.
Rai Sahib Lala DAYA KISHAN KHANNA, Executive Engineer, P. W. D., Irrigation Branch, Punjab.	Rai Bahadur.
M. R. Ry. VENKATAKRISHNA IYER AYYADURAI IYER AVARGAL, Executive Engineer, P. W. D. and Deputy Chief Engineer for Irrigation, Madras.	Rao Bahadur.
Mr. LACHMAN DASS, Assistant Engineer, Myittha Irrigation Sub-division, Burma.	Rai Sahib.
Mr. RAMCHANDRA RAGHUNATH KHANOLKAR, Assistant Engineer (Retired), Bombay Presidency.	Rao Sahib.
Mr. NARSINGLAL NIBHANDAS JURIASSINGHANI, Permanent Overseer, P. W. D., Sind.	Rao Sahib.

Mr. F. Anderson, C.S.I., C.I.E., retired Chief Engineer, P. W. D., Irrigation Branch, U. P., who returned from leave at the beginning of April, is taking over the appointment of Chief Engineer, Bahawalpur State, in place of Sir Bernard Darley, Kt., C.I.E., who is retiring.

Mr. E. S. Crump, C.I.E., Superintending Engineer, Punjab, is on leave preparatory to retirement and will retire from the service of Government from 6th July 1937. The Punjab Government offered him a special appointment for a period not exceeding 18 months for compiling a book on his Hydraulic Research work which he investigated during his 30 years' service. He has accepted the offer and is expected to return next October to take up the appointment.

The Secretary hopes that all readers visiting Simla during the summer, whether on duty or on leave, will take the opportunity of visiting the Board's

Library which is situated in the Central Telegraph Building. There has been a proposal, which may be carried into effect this year, for the Library to be opened in the evenings as a reading room, to enable visitors to study current periodicals and other literature.

### Literature.

The following literature was received during the Quarter.

*Readers are reminded that they are at liberty to borrow any of the literature in the Board's Library, in accordance with the rules published in Bulletin No. 3, and to submit enquiries on any matter dealing with irrigation and its allied subjects,*

## PERIODICALS.

### CIVIL ENGINEERING AND PUBLIC WORKS REVIEW.

VOL. XXXI.

No. 366—December 1936.

#### WELDING PRACTICE.

The Second Congress of the International Association for Bridge and Structural Engineering was held in Berlin and Munich from October 1 to October 11. Foreign engineers were struck by the tremendous developments which have taken place in Germany during the last 10 years, specially in the field of structural engineering and welding practice. In Great Britain there are about a dozen or two all-welded steel frame buildings, a couple of welded bridges of small span, and one bridge of large span. In the Continent welding has become common practice. Several hundred all-welded railway bridges have been erected by German State Railways and there is under construction near Duisburg an all-welded highway bridge of 340 ft. single arch span. Many railway station buildings are of all-welded construction. This impetus to welding practice is due to the biggest steel consumers, the German State Railways.

#### NOTES OF THE MONTH.

##### NEW HOWRAH BRIDGE.

Gives the main features of the new Howrah Bridge, the construction of which has started. (See page 25 of Quarterly Bulletin No. 4). The bridge will contain 27,000 tons of steel. It will take 4 years to build and will cost approximately 240 lakhs of rupees.

##### LATERAL FORCES ON STANCHIONS.

The effect of lateral forces on stanchions is of more importance in a single story building than in multiple story buildings. The calculation of bending moments and stress due to these lateral forces is usually made by approximate methods, but the higher

working stresses and more rational assumptions of the magnitudes of the lateral forces necessitate more accurate calculations. In the present article, which is one of a series, the formulæ derived are based on the theory of deflections.

#### INVERNESS BRIDGE.

This is an old suspension bridge over the river Ness and some of the characteristic and unusual features of the bridge are described in the article, with illustrations. A peculiar feature of this bridge is that one pylon is very much higher than the other.

#### HOVE SEA WALL.

Collins.

Description of a reinforced concrete wall of the stepped type for the western promenade of Hove.

#### BUILDING SCIENCE ABSTRACTS.

(Compiled by the Building Research Station, Watford).

##### STUDIES OF HIGH PRESSURE STEAM CURING OF CONCRETE SLABS AND BEAMS.

Menzel.

Describes study of the effect of autoclave treatment on solid slabs of plain concrete and on the bond developed by reinforcing bars in steam cured and moist cured concrete slabs. An important result observed was that the bond stress developed with plain and deformed bars in steam cured specimens was only 30 to 50 p. c. of that developed in comparable moist-cured specimens.

##### REINFORCED CONCRETE ROAD BRIDGE.

Lheureux.

*Science et Ind.* 1936, Special number *La Route*.

Recommendations are given in connexion with the structures required in road construction across small watercourses including culverts, slabs, and straight span bridges up to 65 ft. span. Dimensions, amount of reinforcement and cost of construction are tabulated for structures of different sizes.

VOL. XXXII.

No. 367- January 1937.

#### LIGHTWEIGHT CONCRETE.

Concrete light enough to float on water has been made with expanded slate aggregates. Stronger concrete of strength 600 to 1100 lbs. per sq. inch made with coarse expanded slate and sand weighs 37 to 75 lb. per cft. Such materials make it possible to reduce the weight of floors and partitions by 35 to 65 per cent. The bulletin recently published by the Department of Scientific and Industrial Research under the title "Lightweight Concrete Aggregates" discusses the properties of the following aggregates

and the concrete made from them: pumice, furnace clinker, coke breeze, foamed slag, expanded clays, expanded shales and expanded slates.

Lightweight aggregates have certain disadvantages, such as permeability of concrete made from them which raise doubts as to protection of embedded steel, and dangers of harmful impurities in the case of pumice and clinkers. But these are more than compensated by the advantages, which are lightness and fire-proof nature.

#### NOTES FOR THE MONTH.

##### SVIR HYDRO-ELECTRIC STATION. •

This is a new hydro-electric station on the Svir river recently completed in Russia. The new station will supply cheap power to Leningrad and will also solve the problem of navigation on the Svir river. This huge station of 96000 k. w. capacity had to be built on sand and swamps. The extensive use of reinforced concrete was a feature of the work.

#### CONTRACT NEWS.

##### TRENT CATCHMENT BOARD.

A scheme has recently been approved which provides for the protection of the Trent by the revetting of the concave sides of practically every bend in the river between Gainsborough and the Trent falls. The object is to prevent erosion and to assist the warping up of the foreshore between the embankment and highwater mark.

#### FOREIGN NOTES.

##### A TRAVELLING TOWER CRANE.

Riedig describes a crane which has been specially designed to construct a bridge over the Werra in Germany. The crane comprises a chassis, a tower, and an adjustable jib. The chassis runs on eight wheels which are mounted in pairs, the wheels at each side being driven by an 11.5 electric motor, at the rate of 80 ft. per minute.

#### STRUCTURAL WELDING : A STUDY OF GERMAN PRACTICE : SIGNIFICANT CONTRASTS.

Bondy.

Structural welding is a new development. The practice is more common on the Continent than in Great Britain, where the building Bye-laws and regulations do not mention the subject of welded steel structures. In Germany there is a good deal of valuable literature dealing exclusively with the design in relation to structural welding, while there is practically none in Great Britain. Details of welding practice in Germany and of testing welded joints have been described.

# REMODELLING CHANNELS AND SLUICES IN THE CAUVERY DELTA.

Pillai.

Abstract of a paper presented before the Annual General Meeting of the Institution of Engineers, India, held in Madras. The author describes the delta and the system of distribution of irrigation water and explains the past and present functions of the principal anicuts (weirs). Some of the defects in the delta are :— Supply much in excess during high floods ; the river and channels silt up rapidly, and the channels and outlets in the upper reaches draw off more water than their irrigation requirements because they have the double duty of supplying irrigation water and relieving the lower portion of the Delta from floods. Most of the difficulties will be overcome by the Mettur Reservoir. The remodelling of sluices to discharge the correct quantity was recommended by the Cauvery Delta Committee. At many of the sluices the silt is considerably below the river bed. These are to be raised. A head of six inches over the highest land in the irrigated area is allowed. It was found necessary to regrade the channels with grade walls having notches, to maintain the necessary level for the high area. The author observes that to fulfil the recommendation of the Cauvery Delta Committee with regard to automatic proportionate discharge from the maximum capacity level and also from normal level, is practically impossible unless modules are provided. This has not been found fully satisfactory in Northern India and has not yet been attempted in Southern India.

# LOCHABER WATER POWER SCHEME : THE SECOND STAGE DEVELOPMENT.

Naylor.

Extracts from a paper read before the Institution of Civil Engineers. The object of the scheme is to generate electric power for the manufacture of aluminium. The waters of the Loch Treig catchment were conducted by a tunnel 15 ft. in diameter and 15 miles long to a pipe line, power house, and tail race near Fort William. The second stage of the scheme is to convert Loch Lagan into a reservoir and to convey its waters along with the flow from intermediate catchments into Loch Treig, where the storage capacity and mean head will be increased. The final capacity for the power station will be 120,000 h. p.

The construction of Laggan Dam is described in some detail. This is a concrete gravity dam slightly curved in plan with a radius of 2,000 ft. The concrete was 7 to 1 mix with 2 inch aggregates while in the facing a 4 to 1 mix with 1 in. aggregate was used. The dam was constructed in blocks separated by radial contraction joints 45 ft. apart. Water tightness at the joints was ensured by a joggled copper strip embedded in adjacent blocks.

The joggle is surrounded by a 6 inch diameter cylindrical space filled with bituminous mixture consisting of equal parts of asphalt and coal tar pitch with 15 per cent. of refined coal tar.

To suit the condition regarding the maximum permissible flood level in the reservoir, it was necessary to adopt a combined spillway in the form of a plain overflow spillway combined with a battery of six syphons of 3600 cusecs capacity. This is the first instance of the embodiment of a large syphon spillway in any such project in Great Britain. The syphon passages are through the body of the dam itself, with a bellmouth at the inlet, and 4 ft. diameter pipes at the outlet. Inside the dam the diameter is 4 ft. 6 in. The outlet pipes are inclined upwards at an angle of 30 degrees to the horizontal and are fitted with jet dispersers. This ensures that the issuing jet strikes the river bed at the maximum distance from the toe of the dam.

#### PATENTS.

- |  |             |
|--|-------------|
| CONSOLIDATING CONCRETE, ETC., BY VIBRATION.                            | Winkler.    |
| A device for consolidating concrete by vibration by an electric motor. |             |
| VIBRATING APPARATUS FOR MAKING CONCRETE ROADS.                         | Berenguiet. |
| SLUICE GATES.  | Bunting.    |
| A new type of gate for a navigation channel.                           |             |

#### PILES.

A concrete pile driven inside a tube, which is subsequently removed.

#### BUILDING SCIENCE ABSTRACTS.

- |  |         |
|--|---------|
| BEHAVIOUR OF CONCRETE UNDER VARIOUS STORAGE                          | Kayser. |
| CONDITIONS DETERMINED BY MEANS OF MEASUREMENTS OF CHANGES IN LENGTH. | Ruth.   |

No. 368.—February 1937.

#### NOTES OF THE MONTH.

##### RESEARCH ON CONCRETE IN PARIS LABORATORIES.

M. L'Hermite, Director of the Building and Public Works Laboratories of Paris referred to the study of concrete in the laboratories in a lecture to the British section of the *Société des Ingenieurs Civils de France*. "Cements are extremely curious bodies possessing at the same time the peculiar characteristics of solids and the properties of liquids". Cements have been classified as pseudo-solids. Freyssinet has shown that pseudo-solids are composed of an agglomeration of crystals, which owe their reciprocal cohesion to molecular attraction and also to interspread liquid films which act as cohesion agents. If a cement owes its cohesion to water films separating the grains it will be sufficient to reduce to a minimum the distance between their surfaces to have such

a thin film as to induce cohesion. If by some mechanical device one succeeds in drawing the grains sufficiently near, cohesion should start early and setting is accelerated. In the laboratory tests were carried out on a number of mortars composed of cement and water in variable proportions.

Research on the nature of concrete is also carried out in the laboratories. Several papers have been written illustrating laws of vibration. The main conclusions of vibration studies are that for coarse aggregates, a low frequency vibration and for fine aggregates a high frequency vibration should be used. The energy of vibration should be proportional to the mass to be vibrated. A too powerful vibrator leads to the whole mass separating out. It was found that for over 12 per cent. of water content, vibration was useless. Vibration efficiency increases as the water content decreases until the 8 per cent. content is reached. Further decrease in water content lowers the efficiency of vibration.

The laboratories possess the most powerful and the largest testing machine in the world. The testing machine allows of specimens up to 500 tons being handled.

#### FOREIGN NOTES.

##### ROCK FILL DAMS.

Dixon.

For irrigation schemes and for town water supply in Algeria, rock fill dams with an impermeable cover on the waterface or an impermeable diaphragm in the middle of the dam are being constructed where foundation conditions preclude the construction of gravity, masonry, or concrete dams. The impermeable cover or diaphragm is generally of reinforced concrete. Two such dams are described. Bakhadda dam is one of the first of such dams built. It is 148 ft. high, 16 ft. wide at crest and 726 ft. long. The bottom width is 330 ft. The slope of the outer face is 125 : 100 and the inner face is concave, the slope at the base being 100 : 100 changing gradually to 86 : 100 at the top. The impermeable coat on the upper face is not rigid and is of light reinforced concrete with joints in the line of the steepest slope. This coat was laid in two layers, the first 12 in. thick and the second 16 in. thick.

The Bou-Hanifia dam is 180 ft. high. The waterside slope changes from 1 : 1 at the base to 8 : 1 at the top.

#### MOISTURE CONTROL OF CONCRETE AGGREGATES BY VIBRATION.

A new method for ensuring greater uniformity in the strength and other properties of concrete has been devised by the Building Research Station of the Department of Scientific and Industrial Research and is described in Road Research Technical Paper No. 4. The

method consists in saturating the materials used in making the concrete and then vibrating them for a given length of time so as to give them a constant water content which is less than that required for complete saturation. The result is a very uniform sand and water mixture. The apparatus is so simple that it can be used by an ordinary labourer.

**LOCHABAR WATER POWER SCHEME : THE SECOND STAGE DEVELOPMENT.**

Naylor.

Continued from previous issue. Describes the Treig-dam which is a combined rock and earth fill dam with a concrete core wall. The upstream and downstream slopes are 1 in 3. The upstream face of the spillway section is covered with 18" granite pitching on an earth fill. The downstream half is a rock fill of rubble rolled in layers of 12 inches and with a surface cover of Portland cement concrete.

**STRUCTURAL WELDING : A STUDY OF GERMAN PRACTICE : SIGNIFICANT CONTRASTS.**

Bondy.

The article deals with some principles of design which are of importance from the practical point of view having an all-important bearing on the efficiency and economy of the welded structure.

**THE BOWSTRING CURVE : AN AUSTRALIAN APPLICATION.**

Describes a type of roof for large floor areas giving uninterrupted floor space. The roof takes the form of a bowstring curve. The main curved member is an ordinary rolled steel joist curved by a special process fabricated in two sections and joined with bolts at the centre.

**LONGEST SUSPENSION BRIDGE IN AUSTRALIA.**

Describes the Indooroopilly Bridge recently completed over the Brisbane river and gives some details of construction operations. The main suspension span is 600 ft. long.

**BUILDING SCIENCE ABSTRACTS.** (Compiled by the Building Research Station, Watford).

**OBSERVATIONS ON HIGH ALUMINA CEMENT.**

Seailles.

*Quinzieme Congres de Chimie Industrielle, Brussels*, cites data on the calculated and actual lime content of several high alumina cements. Lime content of such products varies widely. A relatively high proportion of iron is also present. A method of determining the content of alumina combined with lime has been described.

**TEMPERATURE EFFECTS IN MASS CONCRETE.**

Davey.

Second Congress on Large Dams, Washington 1936. Author's summary. In a large mass of setting concrete the central portion cools slowly and very high temperatures are sometimes attained.



Factors affecting temperature rise are type of cement, mix proportions, size of concrete mass, rate of placing, the insulation afforded by the shuttering, and external conditions. Study of problems connected with temperature has been carried out at the Building Research Station, Watford, and has included comparison of temperatures attained in the case of 3 large dams with those reached in laboratory tests of cements used in the dams. These investigations are described, and it has been shown that on the basis of laboratory tests it is possible to predict temperature which may be attained in any projected mass concrete structure.

COMPARATIVE TESTS ON THE SETTING HEATS OF CEMENTS.

Grun.  
Kohler.

*Bawing*, 1936, 23/24. A brief discussion of the usual methods of determining setting temperatures.

#### NOTES.

##### FLOW RECORDING.

The principles of flume measurement by standing wave flumes are clearly set out in a booklet entitled "Flume Measurement" issued by Lea Recorder Co., Ltd. It summarises the various types of flume and weir measurement and shows how the standing wave method differs from others and in what way it is claimed to be superior.

## CONCRETE AND CONSTRUCTIONAL ENGINEERING.

VOL. XXXII.

*No. 1—January 1937.*

### THE MODULAR RATIO.—I.

Hajnal-Konyi.

A New Method of Design Omitting 'm'.

An article on the new method of design of reinforced concrete which does not take into consideration the ratio of modulus of elasticity of steel : modulus of elasticity of concrete.

### INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

List of papers dealing with concrete and similar materials to be read at the Congress of the above association to be held in London from April 19 to 24, 1937, is given.

### RESERVOIR AT TAMWORTH.

Radford.

Describes the new reservoir at Tamworth which has a capacity of  $1\frac{1}{2}$  million gallons. The main dimensions are 165 ft. by 90 ft., and the working head of water 16 ft. 6 in. The concrete was vibrated by compressor driven vibrators. The floors and roof were vibrated by a steel plate 9 ft. long and 9 inch wide suitably stiffened with steel angles on which were mounted 3 vibrators.

Experience showed that best results were obtained by using one vibrator to every 4 sq. ft. The period of vibration was 6 minutes for each 4 sq. ft. of concrete, and the frequency of the machines was 7350 shocks per minute.

#### **PNEUMATIC CAISSON PILING AT ROTHERHITHE.**

This method of piling was used for the foundations of a new Thameside warehouse at Rotherhithe. The casing of the Caisson consists of short lengths of steel tube which can be screwed together to give any required length of pile, and is sunk into the ground by excavating the soil from inside by boring tools. When the casing has penetrated to the requisite depth the bottom of the hole is trimmed and a cage of steel reinforcement consisting of six main bars and spiral binding is lowered into the casing. By using an air lock similar to that on pneumatic caissons, the casing is cleared of water and concrete is introduced into it. Because all the concrete is placed and subjected to air pressure at the same time as the casing is withdrawn the surface of the final pile is irregular and has a very high frictional value. A club foot was formed at the base of each pile by introducing cement grout and increasing the air pressure to force the grout into the ballast before starting to concrete the pile.

#### **THE SOIL-LINE METHOD OF RAFT DESIGN.—V.**

Baker.

Continued from previous issues.

*No. 2—February 1937.*

#### **THE ECONOMICAL USE OF REINFORCEMENT IN COLUMNS.**

Hendriksen.

Columns are designed to resist (a) direct loads, (b) bending due to eccentricity, end moments from adjoining beams, or external horizontal forces due to wind, etc. The reinforcement in a column frequently consists of a similar arrangement of rods on each of the 4 faces. The direct load is resisted by the concrete and all the steel, while the load (b) is resisted by the member acting as a beam reinforced in tension and compression. The steel in this case near the neutral axis is of little value and the general practice is to take into account the steel on the two faces parallel to the axis of bending. This assumption is justified when the bending stress is large, but when the ratio of bending stress to direct stress is small it is conservative to ignore the inner steel. A method of adjustment making full use of the reinforcement has been set forth in the article.

#### **THE INFLUENCE OF MOULDING PRESSURE ON THE COMPRESSIVE STRENGTH OF CONCRETE.**

Evans.

In recent years, a large number of manufacturers have adopted pressure in place of hand ramming or to supplement vibration in the manufacture of precast concrete products. In the manufacture

of kerbs, flags, and reinforced concrete floor beams and slabs, large presses have been installed which apply considerable pressure to the wet concrete. The object of applying such an initial pressure is to obtain a concrete from which the mould can be removed as soon as possible. The experiments described in the article have been carried out to determine the influence of the moulding pressure on the strength of cement mortars and concrete having varying water content, and to investigate the possibility of any crushing of the aggregates with application of high pressures. The results have been summarised as follows: "Improved results are obtained in the manufacture of precast concrete products with the application of an initial pressure when the mix is well graded. A better surface finish is also obtained when the mix contains a sufficient quantity of fine material. The water content should be such that the slump is preferably at least 2 in., a semi dry mix as is used with vibrators giving much inferior results..... In regard to moulding pressure permissible on wet concrete much depends on the wetness of the mix, and though a pressure of 2 tons per sq. inch may be applied to a wet and well graded mix, a pressure of 1 ton per sq. inch will produce satisfactory results".

#### THE MODULAR RATIO.—II.

A new method of design omitting 'm'.

Hajnal-Konyi.

Continued from issue of January 1937. A new method of design omitting 'm', the modular ratio has been discussed.

#### UNIFORM FLOW IN PIPES.

Hogan.  
Gibbs.

Continued from issue of December 1936.

#### THE SOIL-LINE METHOD OF RAFT DESIGN.—VI.

Baker.

Continued from issue of January 1937.

### THE ENGINEER.

VOL. CLXII.

*No. 4216—October 30, 1936.*

#### MISCELLANEA.

In a paper before the American Chemical Society, Dr. H. R. Dittmar described a new clear plastic which was claimed to be as strong as glass, flexible and non shattering. This product has been named Pontalite and a factory for its commercial production is in course of construction. It is softer than glass and can be cut, sawn, drilled, and polished as well as moulded readily to any desired form. A liquid intermediate variety can be poured into moulds and hardened and it has been used successfully as an

impregnant for wood, cloth, paper, stone and electrical apparatus. Materials treated in this way are much more resistant to water, oils and chemicals.

#### **DREDGING ON THE RAND.**

Describes the method employed for removing accumulated silt by dredging in the Booysens Spruit Reservoir on the Rand in South Africa. The water in the reservoir was originally 30 ft. to 35 ft. deep but after some years the reservoir got silted up to such an extent that the greatest depth of water was reduced to 14 feet. Various schemes were considered but finally it was decided to use clamshell excavators. The equipment consisted of two diesel clamshell dredges one being mounted on caterpillars, one diesel tug and three hopper barges.

#### **THE THIRD WORLD POWER CONFERENCE.**

Summaries of the texts of and discussions on the following papers are given :—

1. Regional integration of electric and gas utility facilities.
2. Planned utilization of water resources.
3. Rural electrification.
4. Rationalisation of distribution of electric energy and of gas.
5. Utilization of small water powers.
6. National power and resources policies.

Members of the World Power Conference visited the headquarters of the Rural Electrification Administration in Washington to study the work which is being done to promote rural electrification in the United States. A party of members also visited Rosedale Farm, the R. E. A. demonstration farm, completely electrified near Herndon, Virginia. This is a farm of 312 acres out of which 70 acres are set apart as pasture for the dairy herd. Both the farm house and the farm itself have been electrified as completely as possible to demonstrate the many ways in which electricity can be of service to the farmer. In the feed house, feed grinder, feed mixer and corn sheller are worked electrically. In the cowsheds a milking machine, hay hoist, ventilating fans, clipper and curry whisk brush machine are electrically driven. The poultry house is illuminated with *ultra* violet rays and contains an electrically heated incubator and water heater. Electric motors drive the farm workshop plant which contains an electrically heated soldering iron. Pumping and meat chopping are performed by electric power and there is an electric hot bed in the garden. A greater variety of uses for electricity is found in the house, the equipment including an electric fly trap.

A summary of the address by President Roosevelt delivered before the joint session of the World Power Conference and Congress on Large Dams is also given.

No. 4221—December 4, 1936.

INTERNATIONAL CONGRESS ON LARGE DAMS.

Question IV: Design and Waterproofing of shrinkage, contraction, and expansion joints in concrete Dams. This is the second subject considered at the Dams Congress held in Washington. There were eleven papers from eight different countries on the subject. The British practice is to build the dam in sections of 50 ft. to 150 ft. separated by transverse joints. The alternate sections being built up in advance with vertically grooved faces to form a key. Closure on the upstream face is effected by a metal seal consisting of a strip of sheet copper set across the joint and anchored into the concrete on each side. Sealing is also effected by making a dovetailed groove across the joint, filling this groove with concrete and coating the faces of the groove with bitumen, the last two operations being carried out after the shrinkage of setting has taken place. One of the French contributions gives a well illustrated account of the jointing system adopted in 3 important dams recently built in France. The general practice appears to be the provision of joints of the slot and key type. In two of the 3 dams, water tightness is obtained by a reinforced concrete wedge bead bearing against the blocks with the interposition of a bituminous film. The Swiss paper on the subject gives a study of the deformations caused by internal stresses as observed on the Spitallamm dam. The paper in summarizing Swiss experience of watertight joints states that various systems tried have given satisfaction. A concrete wedge bead as used in France has been employed with success. In the Spitallamm dam, copper strips have been used, in accordance with British practice.

The German report on the subject supplies descriptions and drawings of a varied series of joint design employed in Germany. The author summarizes his views by stating that arched masonry gravity dams do not need shrinkage and temperature joints. Straight masonry and all concrete gravity dams have to be provided with vertical joints extending through the concrete. The methods of waterproofing the joints include tightening beads of concrete on the upstream face with prisms of concrete or flexible copper sheets in the inner part. The upstream part of the main joints is frequently filled with bitumen. Asphaltic fabric is employed less often for this purpose.

The Swedish paper describes several forms of watertight joints used in Sweden. Joints made with hard rolled copper sheeting or stainless steel plate with provision for expansion or contraction are regarded as best suited.

A paper entitled "Waterproofing of expansion joints with rubber in the concrete lining of a supply canal of Power Plant at Ladce o<sup>n</sup>

River Vah (Czechoslovakia)" describes a novel device for securing watertightness. The canal has gravel embankments, the bottom and slopes being lined with a waterproof layer of concrete 15 cm. thick. The expansion joints on the slopes are 8 metres apart. For waterproofing a rubber cord of trapezoidal section was inserted mechanically into the joint. Above the rubber is a layer of cement mortar reinforced by an iron bar. To permit expansion a layer of paper was put on one face of the joint.

A paper on expansion joints in Norris Dam, U. S. A., gives results of observations of joint shrinkage at the dam. It is intended, after the lapse of two or three years when the shrinkage joints have reached their maximum opening, to fill the joints with grout to make the structure monolithic. During the discussion on Question IV Mr. Cooper, the President, said that in his opinion one important element in the control of cracking is the use of a water cement ratio that will produce a slump of not over 1 in. to 1½ in. Another point is the use of low heat cement.

#### AMERICAN ENGINEERING NEWS.

Cleaning Muddy Water for Turbines.

For note see page 54 of Quarterly Bulletin No. 4.

*No. 4222—December 11, 1936.*

#### INTERNATIONAL CONGRESS ON LARGE DAMS.

Question V: Study of the facing of masonry and concrete dams. Ten papers were contributed on this subject. The most interesting of these papers was that of Mr. Binnie describing the novel design and construction of the Shing Mun Dam in China (see page 25 of Quarterly Bulletin No. 4).

The German Report is a well documented and comprehensive resumé of German practice. The masonry dams in Germany are protected on the upstream side by a special method, the principle elements of which are (a) a waterproof mortar coating, (b) two or three coats of bituminous anti-corrosive paint applied to the mortar coating, (c) a protective facing of masonry or rammed concrete having a thickness of .6 to .8 metres in front of the waterproof coating and dovetailed into the main structure, (d) a network of drainage pipes in the interior of the masonry behind the protective covering, discharging at the foot of the wall at the downstream side. This system has been found satisfactory.

The Austrian contribution describes in some detail the causes of and the means adopted to reduce leakage through the body of the Tauernmoos Dam in Austria. It is recommended that the number of construction joints be kept as small as possible by building concrete layers of great thickness and the facing on the upstream side should be an apron of concrete or of concrete blocks of large dimensions.

**French practice** is summarized as follows : vibration of the poured concrete ; increase of the cement ratio of the concrete in the upstream part of the dam ; use of bituminous coating applied by cement gun, or of steel reinforcement in the coatings.

**The Swiss contributor** recommends a bituminous coating 5 mm to 20 mm thick reinforced by fabric and protected by a mortar coat applied by a cement gun reinforced with steel and solidly clamped to the body of the dam.

**In Czechoslovakia**, in a recently completed dam, a facing of impermeable concrete was placed separately from the body of the dam and allowed to cool before the intervening space of 2 m was filled.

**The U. S. S. R. paper** is entitled " Use of bituminous materials in construction of high dams " and contains an account of the use of bitumen in the building of the large barrage and hydro-electric power house on Svir river. The use of bituminous coatings for the protection of concrete in massive structures is recommended, where the structure is not subjected to deformations.

**The Bulgarian contribution** states that the best method of waterproofing the upstream face is that suggested for the Bellisker Dam in Bulgaria where a copper-brass sheet interposed between the concrete structure and the masonry face covers the whole of the upstream face of the dam.

**No paper** was contributed by the United States but the general report prepared by a U. S. Army Engineer observes that in the United States the extensive and meticulous measures used in Europe for protecting the upstream faces of dams are not employed. Careful control is exercised over the selection and preparation of materials and their placement. In important structures the practice is to have the concrete adjacent to the exposed face of richer mix and to place it at the same time with the concrete in the main body of the dam to ensure an integral mass.

**In the course of the discussion** it was generally agreed that special facings were unnecessary and the whole dam should be made of superior quality concrete.

## **SOUTH AFRICAN ENGINEERING NOTES.**

### **THE VAAL-HARTZ WATER SCHEME.**

**The construction of this irrigation scheme** is in progress. The waters of the Vaal are to be diverted by dams to the Hartz valley. A large dam across the river Vaal will create an inland sea 90 miles long. From this reservoir water will be conducted along the bed of the river to a pick up weir 350 miles downstream. The weir is half a mile long, a concrete structure with modern scour and sluice gates and electric controls. From this point water will be led off along main canals which are about 100 miles of concrete lined waterways, to distributing canals about 600 miles in length. All

canals will be concrete lined. The canals have been taken through hills at several places and one of the tunnels 4,500 ft. long will be the longest in South Africa.

*No. 4223—December 18, 1936.*

# **INTERNATIONAL CONGRESS ON LARGE DAMS.**

**Question VI :** Geotechnical studies of foundation materials. Eleven reports were considered under this subject. In the British contribution, effect on dam construction of porosity, joints, faulting and other disturbances in solid rocks is discussed. The importance of exploratory boring is stressed and attention is drawn to the knowledge available through the services of the Geological Survey. The French contribution was a paper on "The Application of electrical prospecting to the study of dam sites". The method of electrical prospecting by resistivity measurements is based on resistivity of rocks varying with the compactness of the formation. The method is simple and the equipment is light. The method however does not replace exploration by bore holes, it merely serves as a guide and to reduce their number.

The Swedish contribution is devoted to seismic and electrical methods of sounding to bed rock.

The German paper emphasizes the physical and chemical studies and tests of foundation materials.

The Algerian paper illustrates the methods and problems of geophysical studies by a detailed discussion of conditions encountered at three dams in Algeria.

The American paper is entitled "Engineering Geology of Dam sites". The author discusses exploration methods, core drilling methods, sampling and records, the application of seismic geophysical methods in dam site exploration, and geological features of dam sites in various types of rock. The significance of geological factors in earth dam foundations is briefly dealt with.

A summary of the subject covered by the above papers is given, with a resumé of the discussion.

**Question VII :** Calculation of the Stability of Earth Dams. Fifteen papers were submitted, of which nine are devoted exclusively to the subject of slopes of the dam. Most of the papers are mathematical and do not permit of a brief summary. Dr. Gilboy in a paper of much practical interest says, "The methods of design now available are approximate and their use should be tempered with judgment. . . . Artificial compaction of marked intensity produces unfavourable foundation stresses, which are still unknown quantities". He has given equations indicating the strength of dam foundations.

The Italian contribution pays special attention to the constitution and suitability of materials for earth dams and describes laboratory tests of materials.



Of the French contributions, one deals with the stability of dam slopes, and calls attention to the particularly dangerous conditions to which upstream slopes of dams are sometimes subjected. The second paper deals with an investigation of 4 earth dams in France. In all these dams slides in the upstream face took place as the result of rapid draw-down of the reservoir.

The papers from Japan contain studies of the effect of water seeping through a dam as affecting stability, and results of a theoretical analysis of the seismic stability of earth dams and comparison of the results with those of model experiments.

Two mathematical papers from Russia deal with the analysis of the stability of dam slopes, and with the study of stability of earth dams assuming that sliding takes place along cylindrical surfaces with circular sections.

In the course of the discussion the French delegate mentioned that all failures of earth dams in France that had occurred in the past had been connected with earth slides following rapid lowering of water level. He urged the need of further investigation of the stability of upstream slopes of earth dams in all countries.

#### AMERICAN ENGINEERING NEWS.

##### HYDRAULIC TURBINE EFFICIENCIES.

Improvements in the design of scroll cases and draught tubes for large hydraulic turbines have resulted from experimental studies of the disturbances which occur in these parts of a turbine. Models of 60,000 H. P. units were made to one fiftieth scale. Windows on the top and sides of the scroll case enabled the action of water to be photographed. Soaked saw dust placed in the intake would follow the course of water currents and make them visible in the photographs. The experiments were made in connection with the power plant at Bonneville Dam.

##### HYDRAULIC POWER IN GREECE.

Details of a scheme for exploiting the water power of Greek rivers have been published in the *Government Gazette*. Permission has been granted to carry out surveys for hydro-electric installations of four rivers.

*No. 4224—December 25, 1936.*

##### NON-SKID ROAD SURFACES.

The Department of Scientific and Industrial Research jointly with the Ministry of Transport has published the first of a series of studies of road friction under the title : Road Research Technical Paper No. 1—Studies in road friction : Road surface resistance to skidding. The paper summarises the results of a large number of measurements on roads of various types made under varying climatic conditions and at different speeds, with deductions and

conclusions derived therefrom. In another publication "Road Research Bulletin No. 1, Measurement of non-skid properties of road surfaces" is described the construction and operation of the motor cycle and side car used for test purposes, together with the measuring apparatus employed.

#### **THE SAN GABRIEL ROCK FILL DAM.**

Work is in progress on the world's largest rock fill dam in the San Gabriel Canyon, Los Angeles, California. Disastrous floods in the past have caused great damage to property in the valleys below the dam site and the construction of the dams is expected to remove similar flood dangers. Estimated cost of the dam is £2,400,000. The dam consists of a rock fill the base measuring 1950 ft. and the height from bed rock being 375 ft. The length of the crest line is 1,540 ft. The slopes are 3 : 1 and are benched. The design takes into consideration the possibility of occurrence of earthquakes. The dam is divided into six zones each with a specific quality and size of rock fill. During construction the water is being diverted through a concrete lined tunnel 30 ft. in diameter and 1,850 ft. long having a capacity of 35,000 cusecs. The spillway will cut through rock and is designed to handle 80,000 cusecs. Storage capacity of the dam at spillway level is 60,000 acre ft. and at crest level, 70,000 acre ft. Quarrying is done by means of power shovels after explosives have broken and loosened the material. The methods employed to compact the fill consist of rolling, tamping and hydraulic jetting. Tamping is done by dual rollers designed specially for the work. A plan of the dam, a cross section and a photograph shewing work in progress are included.

#### **CANADIAN ENGINEERING NEWS.**

##### **HYDRO-ELECTRIC PROJECT.**

The largest hydro-electric project under construction in Canada is that of the Ontario Paper Company's 66,000 H. P. plant at Ontario Falls in Quebec. Two 25,000 kVA vertical water wheel driven generators will be installed. The turbines will operate under a head of 200 ft. and will be fed by a penstock 17 ft. 6 inches in diameter.

##### **ELECTRICALLY WELDED BRIDGE.**

What is claimed to be the longest electrically welded bridge on the American Continent spans the St. Anne River on the Quebec-Montreal highway. It is 644 ft. long and consists of six arched spans of steel girders, entirely electrically arc welded.

#### **MISCELLANEA.**

The Middlesex County Council is to spend £59,000 on straightening, diverting and enlarging a mile of the course of the river Crane

between Isleworth and Twickenham to avoid flooding at Uxbridge and Southall.

The hydraulic works at Thessaly in Greece have been inaugurated. These works are for controlling the flow of the river Peneios and draining lake Karla, and will make possible the cultivation of large tracts of marshland.

For some time experiments have been carried out at Medicine Lake near Watertown in the U. S. A. to find a means of making concrete resistant to alkali salts. It has been shown that concrete products cured at a temperature of 100° to 150° Fah. can be made much more alkali resistant by adding calcium chloride to the mix.

### VOL. CLXIII.

*No. 4225—January 1, 1937.*

This issue deals principally with the progress of Engineering, Shipbuilding, Aeronautical and Electrical Industries in 1936.

#### ROADS, BRIDGES AND TUNNELS IN 1936.

During the year 4,500 miles of trunk roads were placed under the direct control of the Ministry of Transport. The roads have become so important a factor in the prosperity of the country that it became imperative that those carrying through traffic should be administered by a Central authority.

The most important bridge building event of the year in Britain was the opening of the Kincardine-on-Forth bridge in Scotland.

The Dartford-Purfleet tunnel was started during the year.

#### HYDRO-ELECTRIC AND RIVER CONTROL WORKS IN 1936.

The following large dams were completed during 1936.

Boulder Dam in America.

Hume Dam in Australia.

The Galloway Power Scheme in Great Britain.

The Chambon Barrage in France.

The Shing Mun Dam in China.

Other dams under construction are the Grand Coulee Dam, the Bonnaville Dam, the Parker Dam and Fort Peck Dam. Illustrations of some of the above works are given.

#### IRRIGATION AND RECLAMATION IN AMERICA.

A short note on the work of the United States Bureau of Reclamation. 133 dams have already been built of which seventy-two are for storage and sixty-one for channel diversion. Besides the above, 35 dams are projected for water conservation in arid regions of which 4 have been completed, 20 are under construction and the rest in various stages of design.

**PATENTS.****SLUICE GATES.**

This invention concerns the arrangement of valves in lock and dock gates for the passage of water into or out of the lock. The valves are formed as a series of pivoted vanes after the fashion of a Venetian blind which are operated together by vertical connecting rods. The vanes may be placed in various positions with the object of creating eddies in the water and dissipating the energy of flow.

*No. 4226—January 8, 1937.*

**HARBOURS AND WATERWAYS IN 1936.**

Describes the new works, extensions and improvements effected in the various docks in the United Kingdom.

**WATER SUPPLY AND SANITARY ENGINEERING IN 1936.**

Describes a few important water supply and drainage schemes under taken during 1936, in the United Kingdom and elsewhere. Amongst works mentioned in Asia are the Shing Mun valley water works and Shing Mun Dam, Hong Kong, and the Pegu Yomas reservoir for the water supply of Rangoon.

**BRITISH PATENT SPECIFICATIONS.****PILE DRIVERS.**

This pile driver is of the internal combustion compression-ignition type. It has a cylinder, and monkey acting on an anvil with a piston. Fuel is injected by a pump. The machine is started by the explosion of a sporting cartridge with a blank charge in a special fitting in the cylinder head.

*No. 4227—January 15, 1937.*

**HARBOURS AND WATERWAYS IN 1936.**

Description of some of the new undertakings in Europe and America.

**HYDRO-ELECTRIC PROGRESS IN CANADA IN 1936.**

Editor's comments on the annual review of hydro-electric progress in Canada issued by the Minister of Mines and Resources, Canada. The addition to the total developed water power was small. The demand for power however, is increasing and the gap between installed capacity and power output is gradually narrowing down.

*No. 4228—January 22, 1937.*

**PHYSICAL SOCIETY'S EXHIBITION.**

One of the exhibits was a paint testing apparatus working on the principle described in the Engineer dated June 15, 1934. The

apparatus affords a certain and rapid means of comparing the protective values in regard to the resistance to corrosion of the metal on which the paint is used.

#### THE SHING MUN DAM, HONG KONG.

This is a dam of unusual design on the Shing Mun river for the purpose of storage to supply water to Hong Kong and Kowloon. The design has been described by Mr. Binnie in a paper presented before the International Congress on large Dams held at Washington. (See page 25 of bulletin No. 4).

The dam consists of 5 parts.

- (1) The thrust block, which is constructed of concrete with a cement content of 300 lbs. per cubic yard and is not impervious to water. Its foundations were only taken down to a brown granite rock of a pervious character.
- (2) Behind the thrust block and supporting it is the rock fill, quarried from granite hillsides nearby. The lower part of the rock fill rests directly against the thrust block. In the upper part a wedge of sand separates the rock fill and thrust block. The outer slope of the rock fill is 1 : 1.5.
- (3) The wedge of sand is intended to compensate for any settlement of the rock fill, or movement of the thrust block.
- (4) The impermeable water face of the dam is made up of two parts. The lower portion is the cut-off wall which goes down to about 80 ft. below the river bed.
- (5) The upper part of the impermeable water face is the diaphragm resting on the buttresses. This is made up of numerous concrete panels 25 ft. by 20 ft. The panels are separated from the thrust block by a layer of bitumen 1/5 inch thick. The joints between the panels were also filled with bitumen and covered by copper sealing strips.

The subsidiary works, namely, the diversion and overflow tunnels, siphon spillway and water supply tower and conduit are also described. Several illustrations and a plan of the dam site are given.

*No. 4229--January 29, 1937.*

#### UNDERPINNING A NEW YORK CHURCH TOWER.

The tower of Trinity Church in New York has a dead weight of 11,900 tons. Yielding of the ground beneath the foundation has led to subsidence which has resulted in tipping the top of the spire which is 274 ft. above the ground, about 17 inches out of plumb. The subsidence was continuous, and it was found that the tower settled 1/8 inch to 3/16 inch in a little more than 4 months.

Immediate steps were therefore taken to arrest any further subsidence by underpinning the tower with piers reaching down to bed-rock. The problem was complicated by the fact that subsidence was continuous, that the bearing surface of the foundation was relatively small compared with the dead weight of the tower, and that the sustaining soil was already overloaded. The existing foundation was about 12 ft., below ground level. The bed rock is at a depth of 58 ft. to 65 ft. below the bottom line of the tower foundation. The tower has been underpinned with 17 reinforced concrete piers. Steel caissons of the pneumatic type were used, and the excavation was done by manual labour in the working chamber. The caissons were subsequently filled with concrete. To offset the loss of bearing surface caused by cutting through the tower foundation for the sinking of the 17 caissons extraneous support was provided by means of temporary shoring in the form of 4 horizontal needles extending through the foundation from the centre of the tower to outlying pits in the church-yards adjoining the Church. The exterior ends of the needles rested on screw jacks.

#### WINTER CONCRETING.

Wigmore

Low temperature reduces the strength of concrete laid during a cold spell. There is a general impression that so long as the temperature does not fall below freezing point, the strength of the concrete will not be adversely affected. This is an erroneous impression. Supposing that the specification calls for a strength in compression of 2500 lbs. per square inch, and in warm weather when the temperature is 65°, a strength of 2750 lbs. per square inch is attained. If the temperature falls to 40°, concrete cubes cast in the low temperature period are bound to show results below the specified minimum of 2500 lbs. per square inch. In winter concreting therefore, particular attention should be paid to the quality of the aggregate and its grade, the quality of water, and the water cement ratio.

Concreting is seldom carried out when the temperature is below freezing point. Should it become necessary to do so, the water and the aggregates should be warmed and the concrete for the first 2 or 3 days should be enclosed by tarpaulins, the air space between the concrete and the tarpaulins being warmed by stoves.

*No. 4230—February 5, 1937.*

#### FORTH AND CLYDE SHIP CANAL.

Barnett.

Describes the features of a projected canal from the Firth of Forth to Clyde bank on the Clyde. The project was under consideration before the Great War. During the war and post war period the project was shelved on account of financial stringency. The project is now being re-considered.

have been completed and the fourth will be started soon. As flood reservoirs only, their construction would probably not have been undertaken but it is fully justified by the maintenance of inland waterways levels during periods of drought. Other works carried out in the Seine to obviate danger of any future floods are the raising of embankments, removing barrages in and outside Paris, narrowing islands that obstructed the waterway, and dredging the river. An important sluice barrage has also been constructed at Chatou. The effect of the reservoirs, though of secondary importance, is estimated to reduce the 1910 record flood level of the Seine by 10 inches. The four reservoirs will impound 128 million cubic metres of water which will increase the volume of the Seine in Paris by 50 per cent. during low water periods.

*No. 4233—February 26, 1937.*

#### MISCELLANEA.

A process for the consolidation of sandy building foundations employed in a number of public construction projects in Germany consists of injecting into the ground through numerous pipes a concentrated solution of sodium silicate followed by a solution of calcium chloride. The process is stated to be applicable only to ground formations sufficiently porous to be penetrated quickly by the solutions. Wet sand is no obstacle to the treatment.

#### DETERIORATION OF STRUCTURES IN SEA WATER.

The sixteenth report of the Committee of the Institution of Civil Engineers on "Deterioration of Structures of timber, metal and concrete exposed to the action of sea water" has been published. The deterioration of reinforced concrete test pieces in sea water is discussed. High alumina cements show a marked superiority. The report concludes with a résumé of marine piling investigations carried out in the U. S. A., and an abstract of a paper on the methods of preparation and application of coatings containing Portland cement with an admixture or arsenous oxide, sand and water.

*No. 4234—March 5, 1937.*

#### WATERLOO BRIDGE.

The approved design of the new Waterloo Bridge consists of 5 spans of 238 ft. replacing the 120 ft. spans of the old bridge. Each span will be made up of twin arches side by side with a flat soffit or ceiling between them 33 ft. wide. The arches and soffit will be of reinforced concrete with 'brushed' surface so as to expose the aggregate. The spandrels of arches forming the outer faces of the bridge will be faced with Portland stone. The piers up to high water mark will be of granite and above that will be faced with Portland stone.

**BRITISH STANDARDS INSTITUTION.****STANDARD METHODS FOR TESTING PUMPS.**

Three specifications have been published dealing with the standard methods for testing pumps for wells and boreholes, for sewage and for vaporizing liquids. In arriving at the formulæ for discharge, consideration has been given to the experimental work and recommendations of Barr, Barnes, Burnell, Rehbock and many others. The views of authorities on the subject in all parts of the world have been specially obtained and correlated. 3

**MISCELLANEA.**

An instrument has been invented by a Soviet scientist for testing metal up to 1 m. thickness. The appliance is based on the ability of sound to pass through metal. If a crack or an air hole occurs in the path of the ultra sound ray, it is deflected. This property is utilized in the instrument. With this instrument it is said to be possible to determine the quality of metal precisely before use.

*No. 4235—March 12, 1937.*

**RAIL AND ROAD.****NEW INTERNATIONAL BRIDGE OVER ST. LAWRENCE RIVER.**

A new bridge is to be built on the St. Lawrence in Ontario. It will consist of 3 separate structures, the American crossing, the Canadian crossing and the International crossing. The first two structures will be of the suspension type and the third will be a rigid frame structure.

**BOOKS REVIEW.**

"Soil Erosion and Its Control" by Ayres. The book describes in detail factors affecting rate of erosion and methods of control, and refers to available data as recorded in the United States.

**INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.**

The Association is representative of the National Testing Associations or equivalent organizations in over twenty five leading industrial countries of the world. Its function is to secure international co-operation, and an exchange of views, experience, and knowledge of materials and their testing. With this object International Congresses are arranged at intervals of 3 to 5 year. One will be held in London this year. The subjects for discussions have been divided into four groups: Metals; inorganic materials such as concrete, natural and artificial stone, etc.; organic material; and subjects of general importance. Over two hundred papers have been received from leading authorities in twenty different countries. The programme of the Conference is given.



## ENGINEERING.

Vol. CXLII.

No. 3702—December 25, 1936.

## BUILDING CODES IN THE UNITED STATES.

Fleming.

The United State Department of Commerce Building Code Committee was organised in 1921 in recognition of a general public demand for greater uniformity and economy in building code requirements. The report of the Committee was embodied in a booklet of 28 pages entitled *Minimum Live Loads Allowable for Use in Buildings*. Some recommendations embodied in the report have been quoted. The American Institute of Steel Construction appointed a Committee of distinguished Consulting Engineers who prepared a *Specification for design, fabrication and erection of structural steel for buildings*. The work of this Committee has been accorded wide and favourable acceptance. The specification gives the maximum static stresses per sq. inch permissible in designing, and the subject is dealt with in considerable detail.

## RECENT DEVELOPMENTS IN HYDRO-ELECTRIC ENGINEERING.

Seewer.

A paper read before the Institution of Mechanical Engineers. The purpose of the paper is to describe briefly some of the most important features in design and manufacture of hydro-electric machinery recently developed by British Engineers. These features afford real advantages both technical and economic to the prospective user and have met with the approval of experienced water power engineers. The following are described.

1. Automatic airfoil flow recorder.
2. The automatic governor-actuator and mechanical drive.
3. Cylindrical balanced valve and discharge regulator.
4. The hydraulic brake.
5. The impulse wheel jet disperser governing device.
6. Impulse wheel bucket fastening.

(See also "The Engineer", dated December 25, 1936).

## NOTES.

## INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

The Congress of the International Association for testing materials will be held in London from April 19 to 24, 1937.

## THE INSTITUTION OF MECHANICAL ENGINEERS.

Discussions on the paper entitled "Recent Developments in Hydro-Electric Engineering".

## THE INTERNATIONAL INSTITUTE OF DOCUMENTATION.

Bradford.

A conference of the International Institute of Documentation was held at The Hague from August 11 to 15, 1936.

**THE WEATHER-OMETER ACCELERATED WEATHERING CABINET.**

This is a new laboratory testing apparatus to determine the action of the sun, rain, and low temperatures on paints, varnishes, asphalts, oil products, roofing and paving materials, insulated wire and cables, and other products exposed to the atmosphere.

**CONCRETE PILE-DRIVING SPECIFICATION.**

This has been issued by the Institution of Structural Engineers. The specification covers pre-cast and *in situ* concrete piles, in which the impact test is relied upon for determining the ultimate resistance to penetration. Piles of the bored or pressure type or those in which the concrete is rammed to form enlarged bases are outside the scope of these specifications.

**JOURNAL OF THE INSTITUTION OF CIVIL ENGINEERS.**

*No. 2—December 1936.*

**SHIP CANALS UTILIZED FOR DRAINAGE.**

Wentholt.

“In many countries the same canals are used for navigation as well as for drainage as for instance in Germany and Italy. In no country is this done so much as in the Netherlands, where conditions were such that it followed as a matter of course that freight and passenger traffic should largely take place by water along the newly dug drainage canals in and outside the *polders*, the reclaimed areas, generally enclosed by dikes, from which the water had been lowered by pumping”.

The author discusses the major points to be considered when a ship canal is to be used for drainage, the permissible velocity of current in a combined navigation and drainage canal and the design of the cross section for such a canal.

The paper was followed by a discussion in which the following points were brought out :

1. The employment of models and the extensive alterations made in the design of structures as a result of model experiments.
2. The method of dealing with incoming streams of which an interesting description has been given.
3. Great care had been taken to try to stop suspended matter from settling in the navigation canals.
4. Further information was called for on the experiments made to ascertain the maximum permissible velocity of the current so as to allow of the maintenance of the slopes and the bottom of the canal in good order.

**EFFICIENCY TESTS OF LARGE MODERN PELTON WHEELS.**

Webb.

This describes tests carried out on four sets of wheels installed at the Shanan Power Station, Jogindernagar, Punjab.

**THE MECHANICS OF THE VOUSSOIR ARCH.**

Pippard.  
Chitty.  
Tranter.

“ In spite of the antiquity of the voussoir arch and the extensive use to which it has been put, the theory of its behaviour never appears to have been adequately examined. Although there is considerable literature dealing with its design, the methods suggested are largely empirical and do not take into account the essential features of the mechanics of the structure. With the object of throwing some light on the problem and if possible of obtaining a more rational basis of design, work has been in progress for some time in the Civil Engineering Department of the Imperial College of Science and Technology and the present paper describes the results obtained during the first stage of the research. It may appear at first sight that such a research is of little practical importance at the present time but a large number of bridges of voussior arch construction exist on highways where the volume of traffic is increasing out of all proportion to the original intention and a decision as to the adequacy of these bridges to carry the far greater loads is a matter of vital importance. . . . .”

The accepted basis of design of a voussior arch is the assumption that no tensile stress can be taken by the mortar joints. The general analytical procedure consists in designing the arch so that the ‘line of resistance’ falls everywhere within the middle third of the depth. This method of analysis would be accurate if the abutments are absolutely rigid but the assumption is a very doubtful one. In the present investigations it was necessary to take into account such factors as spreading of the supports, movement of the foundations, and movements of earth below foundations. The problem to be investigated falls into two parts : the determination of the manner in which a voussoir arch behaves under load ; and the use of the knowledge so gained for the formulation of a method of design. The present paper deals with the first part. The paper describes the experimental apparatus and the tests carried out.

**ENGINEERING RESEARCH.**

The sub-committee on the effect of soils containing sulphate salts on concrete and metal pipes, obtained in response to a questionnaire, much information regarding the occurrence of soils containing sulphate salts and the deterioration resulting therefrom. They also prepared a programme of research into the deterioration of concrete in sulphate bearing soils. While sulphate salts are

undoubtedly the main cause of deterioration, it was felt that all corrosive soils should be considered. A new sub-committee to deal with the subject was formed.

The sub-committee to investigate the problem of wave pressures on sea structures proposed to carry out a preliminary investigation by means of small scale models and to attempt to correlate the results with wave action of moderate intensity at some readily accessible point on the coast.

#### RESEARCH WORK IN ENGINEERING AT KING'S COLLEGE, LONDON UNIVERSITY.

Civil and Mechanical Engineering : Research in the following subjects has been carried out.—

1. Stresses in structural frameworks.
2. Creep of concrete under sustained loads. The porosity and volume change of concrete bricks are also being studied.
3. Investigation into the elastic breakdown of steel under various distributions of stress.

*No. 3—January 1937.*

#### METHODS OF PROVIDING PERMANENT NON-SLIP SURFACES FOR ROADS. Keep.

The above subject was introduced for discussion at an informal meeting of the Institution. The author summarized the position regarding the provision of road surfaces which would remain permanently non-slip. The materials for non-skid surfaces described in the article are: concrete, mastic asphalt and rock asphalt finished with hard stone chippings, and rolled asphalt. During the last few years "thin surface coats" laid to a thickness not exceeding 1 inch, had been developed. They are expected to remain non-slippery for at least 5 years. It is too early to assess their durability. In the course of the discussion details were given of research being carried out at the City and Guilds College on selection of a suitable road surface.

#### THE LOWER ZAMBEZI BRIDGE.

Handman.

The Lower Zambezi Bridge recently constructed in Portuguese East Africa is the largest bridge in the British Empire. The total length of the Bridge is 12,064 ft. It consists of 33 main spans of 262·5 ft., seven secondary spans of 165·0 ft. and six approach spans of 66·5 ft. with a viaduct 1,847 ft. It is designed for a single track railway of 3 ft. 6 in. gauge. The main part consists of steel through spans supported by concrete piers built on wells. The wells are of the open dredging type with two dredging holes 9 ft. 6 in. in diameter and have an overall dimension of 36 ft. by 20 ft. The well curbs are of steel with a cutting edge. For sinking under compressed air a cast steel dome with a hinged door attached to the top of the steel curb was used. A 4 ft. diameter shaft connected the top of the dome with the air lock

at the top of the well. This apparatus was originally designed for sinking wells in the Kalabagh Bridge over the river Indus.

#### **THE CONSTRUCTION OF THE LOWER ZAMBEZI BRIDGE.**

Howorth.

This paper describes the construction operations. It has an appendix incorporating medical notes on work in compressed air, and analyses of cases of caisson disease.

In the course of the discussions, the following points were raised :

In sinking through granular materials the amount of kentledge required may perhaps be greatly reduced or eliminated if a rapidly vibrating load is applied. The length of the bridge was too great in view of the comparatively small discharge and low velocity. Had the question of building training works and thereby reducing the effective length, been considered? This method of approaching the problem was stated by the speaker, Mr. Nichols, to be the standard practice in India. He stated that the length of each span adopted seemed to be short in comparison with the size and depth of the piers.

#### **THE MAINTENANCE OF WATERWAYS TO HARBOURS AND DOCKS.**

Carpmael.

In this paper the question of maintenance of waterways has been dealt with under two headings: the causes of accumulation of silt in navigable waterways and destruction of works constructed for their protection; and the methods employed to maintain the waterways.

The causes of siltation are: direct sea action causing coastal erosion in one area and deposition of the eroded material in another, and deposition of silt brought down by rivers. The effect of construction of artificial barriers has been shown by a number of sketches, and actual examples quoted.

The methods employed to maintain the waterways are, (a) maintenance by artificial works such as groynes and training walls to arrest and divert the sand and shingle, (b) physical removal by dredging or sluicing. The former covers a wide field and has been briefly touched in the article. The latter has been treated in detail.

The question of silting of Madras harbour referred to in the paper was discussed in some detail.

#### **ENGINEERING RESEARCH.**

The Institution Research Committee. In the December journal, the formation of a Committee on Soil Corrosion of Cement Products was announced. Another sub-committee on Repeated Stresses in Structural Elements has been formed, the programme of which consists of a series of repeated bending tensile, impact and hardness tests on specimens cut from girders.

**RESEARCH WORKS IN ENGINEERING AT BATTERSEA  
POLYTECHNIC INSTITUTE.**

The following researches are in progress :

1. Investigation into the production and properties of vibrated concrete by an apparatus in which vibration is produced by electro-magnetic means.
2. Phenomena associated with healing of concrete after cracking.
3. Researches dealing with reinforced concrete.
4. Researches into the strength and rigidity of R. S. joists loaded in torsion.
5. Investigations of the effect of varying the angle of flow over notches of trapezoidal section.

*No. 4.—February 1937.*

**THE REPORT OF THE SEA ACTION COMMITTEE.**

Shaw.

This subject was introduced for discussion at an informal meeting of the Institution. In the section dealing with the corrosion of iron and steel the important points noted are (1) the excellence of cast iron under aerial conditions and its unreliability when immersed, (2) disappointing behaviour of special steels under immersion, (3) the large amount of corrosion under all conditions of exposure in wrought iron and mild steel.

In connexion with the protection of iron and steel it is mentioned that thorough cleaning of the metal before applying any coat of paint is essential. Cleaning by sand blasting was superior to other methods. Tar is a very satisfactory coating for iron and steel, and red oxide proved the most satisfactory of the oil paints.

The durability of reinforced concrete was confirmed by tests, provided the steel was amply protected by concrete. A dense concrete was found to offer good resistance to action of sea water. A dense concrete could be obtained by using properly graded aggregate with sufficient cement and as little water as possible to ensure proper working.

The section on timber could be summed up in the words of the report :

“No process for the preservation of timber was found more satisfactory than impregnation with creosote.”

**THE SECOND-STAGE DEVELOPMENT OF THE LOCHABER  
WATER-POWER SCHEME.**

Naylor.

The paper outlines in brief the complete scheme.

The rise of internal temperature and its relationship to cracking in a concrete dam were studied at the Laggan Dam and the results of the study have been set forth. Arrangements were also made

to study the deflexion of the Laggan Dam and the deflexions as measured and calculated have been compared.

In an appendix the author gives formulæ for derivation of the temperature curve and a mathematical treatment of deflexion in a dam.

In the course of the discussion the important features of the scheme such as siphon spillways, the experimental work at Laggan Dam, the treatment of cracks in the concrete, etc., were mentioned.

(Also see Civil Engineering and Public Works Review, January and February 1937 in this Bulletin).

#### PRE-STRESSING BRIDGE GIRDERS.

Nichols.

The railway bridge over the Nerbudda river near Broach was lately rebuilt. In the design of the main girders for a span of 282 ft. steps were taken to eliminate the deformation stresses as far as possible so that the working stresses could be assumed 9 tons instead of 8 tons as usual. The condition that deformation stresses should be reduced to a minimum implies that in this state members should be as nearly straight as possible. In the usual method of construction the structure is normal when erected, and when the load is applied—due to the rigidity of the joints—the members are bent. If the members during erection could be bent in the reverse direction, then the application of the designed load would remove this bending and the members would become straight under full load. This result could be obtained theoretically if each member in the frame were lengthened or shortened by an amount equivalent to its calculated strain under the designed load, whilst the drilling of gussets was such that intersection angles of the uncambered frame were preserved. This 'pre-stressing' of the members of the truss would produce a truss of a deformed shape and would be erected in that condition. When the design load covered the whole span, the camber increment in each member should be neutralized by the elastic strain leaving all members straight and free from all but axial stresses.

Advantage was taken of the excellent opportunity offered during erection of the steel work to carry out a careful investigation into the stress which actually occurred in a steel frame and their comparison with the calculated stresses. The instruments used, the procedure, and determination of deformation stresses by a model truss built 1/50 of the linear scale, are described in detail. The author states that a substantial reduction in deformation stresses has been obtained by pre-stressing. Lateral bending stresses may be considerable and there is no better method of examining these stresses than that based on the use of models. In conclusion he proposes some modifications for pre-stressing as applied

in the case of the Nerbudda Bridge. An appendix deals with the design of the scale model of the truss.

In the course of the discussion it was pointed out that much of the effect of pre-stressing lost on the Nerbudda Bridge could be attributed to faulty drifting and rivetting.

**STRESS-DETERMINATION FOR A THREE-DIMENSIONAL  
RIGID-JOINTED FRAMEWORK BY THE METHOD OF  
SYSTEMATIC RELAXATION OF CONSTRAINTS.**

Richards.

The method of systematic relaxation of constraints for calculating stresses in a framed work has been recently developed by Professor Southwell. The basic idea of this method is to assume that all joints in the structure are prevented from changing position by imaginary constraints. The load is then applied and is initially resisted by the constraints. The constraints are then systematically relaxed.

In this paper the method is applied to a rigid frame structure. In a foreword a short account of relaxation methods emphasizing principles but avoiding mathematical details has been given by Professor Southwell, the originator of the method.

**ENGINEERING RESEARCH.**

Special cements for mass concrete structures and their specification. Mr. Lea summarizes the present position with regard to special cements in this report, which reviews the progress made in the production of low heat cements and discusses the specifications and properties of such cements. A table giving the American specification for low heat and modified Portland cements is included. No low heat cement has been produced in Great Britain on a commercial scale up to the present.

**RESEARCH WORK IN ENGINEERING AT WOOLWICH  
POLYTECHNIC.**

The variation of the coefficient of expansion of concrete with different proportions of aggregates is being studied.

**JOURNAL OF THE INSTITUTION OF SANITARY ENGINEERS.**

Vol. XL.

*Part 6—June 1936.*

**DETERIORATION OF CONCRETE OWING TO CHEMICAL  
ATTACK.**

Lea.

A paper read at a meeting of the Institution of Sanitary Engineers. Chemical agents destructive to cement are: sea water, natural moorland waters, ground waters containing sulphates, trade wastes, oils, and solutions, to which concrete may become exposed in industrial construction. The chemical attack of



concrete takes place by action between the set cement and the destructive agent involved, the aggregate being generally unchanged. The quality and properties of cement are a major factor in determining the extent of attack.

## THE ROYAL ENGINEERS JOURNAL.

Vol. LI.

*March 1937.*

COAST PROTECTION ON THE NORTH SEA COASTS OF  
HOLLAND, FRANCE, BELGIUM, AND GERMANY.

Burgt.

The coast line of the eastern borders of the North sea consists mainly of sand and is protected by works of very dissimilar construction. The article presents a study of some of the existing coast protection works and their effects. The coast protection works are of two types; longitudinal, such as sea walls and sea dykes; and perpendicular to the shore, such as groynes. Some of these are described and cross sections of several types of such works are given. Studies of coastal phenomena and other investigations and data necessary for design of suitable coast protection works in the future are discussed. The eastern sea board of the North sea is subject to erosion in several sections and the protection of the coast offers complicated problems for which a thorough study is needed. A general investigation of the Dutch coast, and study of erosion of the coast have been started.

SEALING OF HANNA LAKE.

Pocock.

Hanna Lake is eight miles from Quetta and stores water in the rains for irrigation during the rest of the year. Some years ago an abnormal decrease of the stored water was noticed and investigations by the Irrigation Department led to the conclusion that water percolated through the surface soil and seeped away through fissures in the underlying rock. It was decided to seal the suspected area with gunite and the work was done by the M. E. S. for the Irrigation Department. A guniting plant was purchased and the work was done by direct labour. The general process of guniting is described with special reference to the various components of the plant and their action, and the special characteristics of gunite are mentioned. Then follows a detailed account of the work at Hanna. Gunite applied to rock was perfect. When applied to a sloping earth surface, the gunite developed cracks. The probable causes of the cracks are discussed. It is stated that on a sloping earth surface it is difficult to gauge the required degree of wetness and the exact thickness of gunite. Maximum thickness for gunite is limited to  $1\frac{1}{2}$  inch, and cracks appear if it is thicker. While the work was in progress the earthquake of May 1935 occurred which disorganized

the whole work. Work was re-started as early as possible afterwards, but the work done after the earthquake developed cracks, which were attributed to the minor shocks which continued to occur for some time after the main earthquake. It is stated that the earthquake had no effect on gunite applied to the rock surface.

## WATER AND WATER ENGINEERING.

VOL. XXXVIII.

*No. 472—Winter 1936.*

### GERMAN WATERWORKS PRACTICE.

Bowman.

Paper presented to the Institution of Water Engineers. The writer gives a brief description of the river systems of Germany and the geological features of the country, the annual rainfall in different tracts and then comes to the main subject, the development of German water supplies. The use of water from upland surfaces by the construction of storage reservoirs is not general. River water as a means of supply is being eliminated and ground water being substituted.

### THE HYDROGEOLOGY OF THE LOWER OOLITE ROCKS OF ENGLAND.

Walters.

Paper presented to the Institution of Water Engineers. The general direction, extent, and magnitude of the underground flow in the Oolite are discussed. The chemical changes that occur in the underground water are also discussed in broad outline.

The above knowledge is applied in the selection of sites for wells and bore holes, and in some instances affect considerations of stream flow and reservoir design.

VOL. XXXIX.

*No. 473—January 1937.*

### EDITORIAL NOTES.

#### PRESERVING UNDERGROUND WATER.

Sir Charles Tyrrell Giles in a letter to the Times says that nothing is done to retard receding of underground water. The sinking of deep wells caused the exhaustion of artesian wells in Streatham. The level of underground water is lowered as time goes on. If local authorities, when carrying surface water drains through porous soils, were to make occasional loose brick pits to act as soakaways, vast volumes of water would be restored to the natural reservoirs instead of running to waste.

**THE GREAT OUSE CATCHMENT BOARD.—PART I.**

Borer.  
Gribbin.  
O'Shea.  
Pattison.

An article describing the formation of the Board, their jurisdiction, the works which the Board have in hand, and other schemes which are contemplated. The main work is the improvement of rivers, which consists of hauling out trees from the channel, and clearing the watercourse by means of crooms, or by digging out the bed in places. The various derelict navigations have been taken over, and old sluice gates and locks are being put in order. A scheme for deredging and raising the banks in a portion of the river in the south was completed two years ago. Reconstruction of Brownshill Staunch and St.Ives Staunch which were old locks on the river Ouse with sluice gates, has been described. In the former, anti-scour teeth of a pattern patented by Professor Rehbock of Karlsruhe, were constructed on the downstream side of the three new radial steel sluice gates. There were scour holes below the old gates which are now filling up after the reconstruction of the sluice gates and provision of anti-scour teeth.

**BOREHOLE PUMPS.**

Describes a special type of pump for lifting water containing sand.

**PETROL ENGINES FOR PORTABLE WELL BORING EQUIPMENT.**

Describes a portable drilling rig capable of drilling a 6 inch hole to a depth of 800 feet, powered by a 24/28-H.P. petrol engine.

*No. 474—February 1937.*

**THE GREAT OUSE CATCHMENT BOARD.—PART II.**

Borer.  
Gribbin.  
O'Shea.  
Pattison.

Continued from previous issue. Describes the construction of the tidal model of the Great Ouse and the Wash. The object is to enable engineers to study the effects of the numerous factors bearing on the drainage of the area and to test the efficacy of the various schemes prepared for the improvement of the river and its outfall. A very detailed account of the model and its special features is given. Calibration of the adjusting mechanism for the tidal range and the experimental work in that connexion leading to the correlation of the estuary and mode have also been described.

**THE DEVELOPMENT OF PNEUMATIC LEVEL MEASURING DEVICES.**

Lambert.

Describes a few early types of devices for measuring depth of water in tanks in terms of water pressure. The instruments are of the

pointer type, the pointer being operated by water pressure applied either directly or through air trapped in a tube connecting the water and the pointer. The gradual improvements in these measuring devices led to the modern instruments which are described in detail.

#### FOREIGN AND COLONIAL.

*Europe.*—The reclamation works in Thessaly, Greece to control the flow of the river Peneios and drain lake Karla, making possible the cultivation of large tracts of marshland, have recently been inaugurated.

*Asia.*—Plans have been approved by the U. S. S. R. for the construction of an extensive system of hydro-electric stations on the Chirchik river. The project is designed to supply power for the irrigation of the Tashkent Oasis and the production of nitrogen fertilizers for the cotton districts of Central Asia. The main features of the project are the construction of regulating reservoirs in the upper Chirchik, construction of a large canal connecting the three power stations and diversion of about 20 tributaries of the Chirchik river which bring down considerable alluvial deposits to the main river.

#### WATER SUPPLY SCHEMES IN SOUTHERN INDIA.

Mr. F. W. Ireland gave a lecture on engineering experience in India at a meeting of the Birmingham Association of the Institution of Civil Engineers. He described some of the methods employed in water supply schemes in the Madras Presidency, and gave an account of flood damage and repairs on a large river and discussed the investigation and design of a large irrigation scheme.

#### MONTHLY REVIEW OF CURRENT LITERATURE.

Movable Barrage by V. Cherre. *La Technique Moderne* October 15 and November 1, 1936. Deals with the barrage with lifting sluice gate in the first article and the barrage, in segments, of roller crests in the second article. Latest improvements are described and illustrated, and the subject is treated mathematically.

#### MODERN WELL WATER DEVELOPMENT.

Beauchemin.

In the past few years much progress has been made in subterranean water development. Drilling of the borehole is only a first step to a series of developments which are necessary to obtain a given volume of water. The borehole reveals the hydro-geological conditions of each stratum. The particular stratum to be developed for supplying water depends on the quality of water and the nature of requirements of the user. If a sand water-bearing formation is decided upon, a screen will have to be placed opposite the formation for the purpose of holding in place the gravel which will be used to filter out the water from the sand.

The gravel is placed by special devices and methods. Contamination by seepage from surface water is prevented by a clay seal round the tubing.

No. 475—March 1937.

## EDITORIAL<sup>1</sup> NOTES.

### IMPORTANCE OF RIVER GAUGING.

Mr. Barton, engineer to the Severn Catchment Board says : " Before any works affecting the control of a river are undertaken it is essential that the fullest information regarding volumetric discharge should be obtained. Attempts at estimating discharge by theoretical formulæ are only approximate and not to be relied upon. Establishment of gauging stations and keeping careful records over a number of years is the only way by which the information can be obtained."

### COTTON LININGS FOR IRRIGATION CANALS.

The experimental roads laid with a membrane of cotton are proving so satisfactory in the United States that engineers there are now applying the same principle to the lining of roadside ditches which will prevent weeds from growing up through the surface cracks. This reinforcing principle is also to be applied to irrigation canals to assure delivery of water without loss through seepage *en route*. Engineers are also thinking of applying the principles in combating soil erosion by applying cotton membrane to terrace run-off ditches.

### THE CONSTRUCTION OF LARGE MODERN WATER DAMS.

Coyne.

The article describes the main features of modern dam construction in France with special reference to a number of dams recently constructed in that country. Up to 10 years ago, the gravity dam was the usual type. Lately the arched type of construction has been adopted in several large dams. Calculations of such structures are complicated. Lacking precise calculations however, it is quite possible to obtain satisfaction from approximate rules which err on the safe side. An arched dam may be likened to a curved plate fixed on three sides. The influence of the fixing of the arch at the bottom and the necessity or otherwise of increasing the efficacy of this fixing was studied by examinations and observations in existing dams. The result was that the author decided to reduce the efficacy of the fixing and make the work more flexible in the vertical direction. This principle was adopted in the Mareges Dam, 90 metres high. The cross section of the dam presents the appearance of a double curved hull with an overhang on the upstream side. The maximum length of overhang is 7 metres. The arch is supported on its base through the intermediary of large concrete props cast with it. A dry joint is provided between the props and the base to

allow the props to rise slightly from their support when the retained water reaches its highest level. It was considered useful to ascertain whether this would actually be the case. This was done with a special acoustic stress detector which is described. Tests at Mareges Dam show that the props instead of rising as they were expected to do theoretically, actually settled.

The author calls attention to the bold and elegant lines, slenderness, and cleanliness of design of the Mareges dam. It has to stand up to a water thrust of 450,000 tons. Recently, a dam in Algeria, the Grand Cheurfas dam was strengthened by securing the work to the ground by ties (see page 4 of Bulletin No. 1). A similar arrangement was used in the right abutment of Mareges dam which is built on a narrow granite ledge. The Mareges dam is provided with 2 discharge tunnels and a free overflow on one of the abutments. The discharge tunnels are on the left bank and function with free flow. The form of the intakes were decided upon after most careful investigations with models. The overfall on the right abutment is in the open air. Instead of being prolonged to the base of the dam it stops abruptly at mid height. The sloping sheet of overflowing water is thus detached and its point of fall is far from the vulnerable parts of the structure.

#### THE RAINFALL ASSOCIATED WITH THE FLOODING IN ENGLAND AND WALES DURING JANUARY 1937.

No year passes without occurrence of more or less serious floods in some part of the British Isles. The flooding is more liable to occur in winter when rainfall exceeds that in summer and there is little evaporation. A close study of rainfall and run off will enable forecasting of floods. The main features of the weather conditions in January 1937 are described and the rainfall at various places, and it is concluded that 'the widespread flooding has been due to persistent and frequent rains, the amounts for any one day being quite unexceptional.'

#### RAND WATER BOARD.

Under the Vaal development scheme, the Government is constructing Vaal Bank Dam which will provide a storage of 873,000 acre feet. The main dam is concrete gravity type and will hold up 100 feet height of water.

#### MONTHLY REVIEW OF CURRENT LITERATURE.

WATER SUPPLY FROM BOREHOLES. *Manchester Guardian Commercial*, Dec. 24, 1936.

Advantages of the centrifugal pump are detailed. The main advantages are the absence of all valves, and a uniform flow.

DEVELOPMENTS IN HYDRO-ELECTRIC PRACTICE IN CANADA. Hogg.  
*Canadian Engineer*, December 8, 1936.

Review of progress made in the design and construction of hydro-electric plant, particularly turbines, governing equipment and generators.

THE MULTIPLE ARCH CONCRETE DAM ON THE RIVER KSOB. Alexandre.  
*La Technique Moderne*, January 1, 1937.

Description of the dam now under construction in South Algeria. It will be 46 metres high and 261 metres length at crest. The structure comprises 38 bays 6 metres wide in thin concrete. An interesting system of metal scaffolding is mentioned.

# PUBLICATIONS OF THE IMPERIAL BUREAU OF THE SCIENCE, HARPENDEN, ENGLAND.

## PUBLICATIONS RELATING TO SOILS AND FERTILIZERS.

*List No. 64—November 1936.*

*List No. 65—December 1936.*

Among those listed are the following two articles published in the Transactions of the Soviet Section of the International Society for Soil Science, Vol. 5, 1936. The abstracts given below are copied from the list. The articles are not available in this office.

TECHNIQUE OF THE TREATMENT OF RESULTS OF FIELD DETERMINATIONS OF PERMEABILITY. TsypLenkin.

*Abstract.*—The change of permeability ( $K$ ) with time ( $t$ ) of continuously flooded soils is expressed by the linear equation:  $\log K_t = \log K_0 - a \cdot \log t$ , where  $a$  expresses the diminution of permeability with time. Soils in which  $a$  exceeds 0.7 are liable to salt danger when irrigated.

DETERMINATION OF THE DEGREE OF SOIL SALINITY BY THE ELECTRICAL CONDUCTIVITY METHOD. Davydov.

*Abstract.*—An electric cell consisting of a 50 cc. glass container with latton (a brass-like alloy) electrodes, with a Kohlrausch bridge was used for determining the degree of soil salinity in the field.

*List No. 66—January 1937.*

The following is one of the articles listed, together with an abstract. The article is not available in this office.

SOLONETS-SOLONCHEK COMPLEXES IN THE DEPRESSION OF BOLSHAIA MAITUGA, KUIBSHEV REGION. Eremin.

(Pedology, No. 5, 1936).

*Abstract.*—Morphological studies of saline solonchetses. Reclamation measures should include lowering the water-table, leaching salts and treatment with gypsum.

## MONTHLY LETTERS.

*No. 61—November 1936.*

"We reproduce below a discussion from the "East African Agricultural Journal Vol. II, No. 2 on a problem which may have arisen in other parts of the tropics." The subject is: The Unsuitability of Certain Virgin Soils to the Growth of Grain Crops by N. V. Rounce.

Certain types of soils when put down to crops for the first time are entirely unsuitable in the first few years to the growth of grain crops, yet they will produce excellent crops of legumes and fair yields of potatoes. The reasons for this inhibition of growth and the best means of overcoming it are the points at issue.

Mr. G. Milne in a note has suggested a possible explanation. Cereals for their growth depend on a well timed supply of nitrogen, supply of which is very low in such soils. Legumes obtain nitrogen from the air so they thrive well in such soil.

*No. 62—December 1936.*

Describes in detail a new apparatus for separating insects from soil. The principle of the method is flotation by a dense liquid in a cylinder aided by stirring of the soil and a stream of fine air bubbles passing from the bottom upwards, through the mixture of soil and solution. A froth is produced which contains all the insects.

*No. 63—January 1937.*

The letter deals with the action of sunlight on the soil with particular reference to the investigations carried out by Prof. N. R. Dhar and his associates at Allahabad. They have shown that ammonia is oxidized to nitrate in the presence of sunlight. They also claim to have demonstrated a non-bacterial fixation of atmospheric nitrogen when carbohydrates and other energy rich materials are added to sterilized soil exposed to sunlight. This reaction may find a practical application in the use of molasses for reclaiming alkali land, the effect being to increase the acidity and nitrogen content of the soil. It is however questionable whether naturally occurring organic compounds react at all in nature at ordinary temperatures except in the presence of living matter. "If organic compounds were allowed to run amuck there would long ago have been an end to the delicately poised organization of life. . . . We are thus faced with the question whether soils, apart from their fauna and flora, should be regarded as living *per se*. . . . Even if we agree to call the soil alive we cannot expect to find the ordinary characteristics of life sharply defined, but vague indications like the occurrence of organic reactions induced by solar or terrestrial radiations, which leave the way open for endless argument".



**SUMMARY OF RECENT REPORTS, NOVEMBER 1936.**

Gives summaries of reports of institutions in various countries regarding agricultural operations.

**BIEDERMANN'S ZENTRALBLATT.**

für Agrikulturchemie und rationellen Landwirtschaftsbetrieb.

(In German).

VOL. 65.

*Heft 7/9—March 1936.*

Besides the following article the journal contains abstracts (In German) of a large number of publications and articles on agricultural problems.

**ON THE APPLICATION OF NEW ADVANCE IN pH DETERMINATION IN SOIL RESEARCH.**

Karsten.

**WASSER UND ABWASSER.**

VOL. 33.

*Heft 10—October 1, 1935.*

The journal contains abstracts of publications and articles about water and sewage. The abstract on the following article has been translated :—

**USE OF PAINT FOR STEEL WORKS ON HYDRAULIC STRUCTURES THAT REMAIN UNDER WATER.**

Kindscher.

(Bitumen, 1935, Vol. 5, No. 5, pp. 89-93).

**SCHWEIZERISCH BAUZEITUNG.**

(In German).

VOL. 107.

*No. 21—May 23, 1936.*

**DAM ON THE SPITALAMM FOR THE POWER HOUSE AT OBERHASLI.**

Juillard.

This describes the design and construction of a concrete arched dam.

*No. 22—May 30, 1936.*

**DAM IN THE "SORPE" VALLEY IN RUHR.**

Contains a short description of the dam.

*No. 23—June 6, 1936.*

**DAM ON THE SPITALAMM FOR THE POWER HOUSE AT OBERHASLI.**

Juillard.

A continuation of the article in the issue of May 23, 1936.

*No. 24—June 13, 1936.*

**DAM ON THE SPITALAMM FOR THE POWER HOUSE AT  
OBERHASLI.**

**Juillard.**

The concluding article on this dam. Deals with deformation and temperature changes.

*No. 25—June 20, 1936.*

Nothing of interest to irrigation engineers in this issue.

*No. 26—June 27, 1936.*

**THICK METAL COVER FOR DAM WALLS.**

**VOL. 108.**

*No. 1—July 4, 1936.*

**THE PROBLEM OF WAVES.**

**Favre.**

A theoretical discussion on wave motion.

*No. 2—July 11, 1936.*

**THE PROBLEM OF WAVES.**

**Favre.**

A continuation of the article in the previous issue. Deals with experiments at the Port of Algiers and on a model.

*No. 3—July 18, 1936.*

**WIND PRESSURE ON CHIMNEYS WITH CIRCULAR CROSS  
SECTION.**

**Ackeret.**

Describes experiments with a model chimney in a wind tunnel.

**STEARMANN'S METHOD OF  $n$ -DEGREES OF FREEDOM FOR  
CALCULATING REINFORCED CONCRETE CONSTRUCTION.**

**CALCULATION OF WELDED JOINTS.**

**Eichinger.**

**BUILDING OF DYKES ON THE HWANG-HO.**

*No. 4—July 25, 1936.*

**CONTRIBUTION TO THE CALCULATION OF SAFETY OF  
EARTH DAMS.**

**Meyer-Peter.**

**Favre.**

**Muller.**

A theoretical treatment of the design of earthen dams with and without cores. It also deals with the theory of slips due to sudden lowering of water against the dam.

Translation of this article is available.

*No. 5—August 1, 1936.*

Nothing of interest to irrigation engineers in this issue.

*No. 6—August 8, 1936.*

**FAILURES OF DAMS IN U. S. A.**

A short account of the failure of a dam due to the waste weir level being raised above that designed, thus reducing waterway. A heavy storm was responsible for over-topping and destroying the dam.

Translation of the article is available.

*No. 7—August 15, 1936.*

**CONSTRUCTION OF THE MOHAWK DAM IN OHIO.**

Describes the methods adopted in the design and construction of this earthen dam.

**FOREIGN PUBLICATIONS ON EARTH DAMS.**

**BITUMEN EMULSION FOR MAKING POROUS SOIL NON-POROUS.**

**FAILURES OF EARTH DAMS.**

The most prevalent cause for failures lies in the unexperienced lay-out of drains in the dams. Other causes are given; also rules for building of dams. (This is a review of an article in another publication.)

Translation of this review is available.

*No. 8—August 22, 1936.*

**MEASUREMENT OF TENSION IN EARTH FILLED DAMS BY SOUND WAVES.**

A short note on a method which has been used with success on a dam in France.

*No. 9—August 29, 1936.*

**SECURITY FROM SKIDDING ON ROADS.**

*No. 10—September 5, 1936.*

**ELECTRO-CHEMICAL METHOD OF MAKING CLAY BED IMPERVIOUS.**

A short note on experiments carried out on laboratory scale—the method has apparently not been given practical application.

*No. 11—September 12, 1936.*

**REINFORCED CONCRETE CALCULATIONS WITH  $n$ -DEGREES OF FREEDOM.**

**REVUE GENERALE DE L'HYDRAULIQUE.**

(In French).

*No. 11—September-October 1936.*

**HARNESSING STREAMS FOR HYDRO-ELECTRICITY :**

Gibrat.

**MATHEMATICAL STATISTICS AND PROBABILITIES.**

This deals with the question of discharges available in rivers throughout the year and forecasting supplies available for hydro-electric generation.

**THE HYDRAULICS OF TIDAL RIVERS.**

Lamoën.

This is the second part of the article and deals with the mathematics of wave motion.

**REVIEW OF SOME HYDRAULIC FORMULÆ RELATING TO DRAINS AND CANALS.**

Bertharion.

This article reviews a number of well-known formulæ for flow in open channels and comments on the merits thereof. The article concludes with a comment to the effect that the laws of unsteady motion and the formulæ of Boussinesq do not denote the real state of affairs owing to the influence of complicated factors to be accounted for in the formulæ, as for example the factor relating to the perturbing influence of friction.

*No. 12—November-December 1936.*

**THE HYDRAULICS OF TIDAL RIVERS.**

Lamoën.

This is the third and concluding article on the theoretical study of rivers influenced by tides. It concludes with a discussion on the theory of the use of models for study of tidal river problems.

**THE SECOND CONGRESS ON LARGE DAMS, WASHINGTON, SEPTEMBER 1936.**

Genthial.

This is an account by Andre Genthial, Secretary of the French International Committee, on the work done by the International Commission on Large Dams of the World Power Conference since its formation, and on the discussions of reports presented at Washington.

**EXPERIMENTAL RESEARCH ON THE RATING OF CURRENT METERS IN STILL WATER.**Bourgeat.  
Deullin.  
Cahuzac.

This is the second article on this subject (the first is in issue No. 9 for May-June 1936) and deals principally with the highly perfected apparatus of this Laboratory (Beauvert) in view of these researches and which has permitted systematic examination of the anomaly noticed for the first time during the rating experiments by Epper.

The author gives an examination of the phenomenon, recalls the interpretations which have been made and develops the question from the analytical and experimental points of view; in particular he disposes of the determination of the maximum of Epper's point.

The conclusions of the author will be published in the next issue.

**THE QUESTION OF THE REJECTION OF AUTHORIZED PROJECTS BEFORE JURISPRUDENCE.**

Huillier.

This deals with the question of water rights and arose in connection with hydro-electric generation. (See also issue No. 7).

## CURRENT SCIENCE.

VOL. V.

*No. 7—January 1937.*

INDIAN SCIENCE CONGRESS, HYDERABAD, 1937 :

## SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS.

## GEOLOGY AND GEOGRAPHY.

President W. D. West.

Speaking on the subject "Earthquakes in India", Mr. West says that earthquakes in India are a legacy of the great earth movements that convulsed the northern flanks of India in the Tertiary and Quaternary times, throwing up the Himalayan and other ranges. For this reason earthquakes are confined to the mountainous regions and to the plains adjacent. Other countries that suffer from earthquakes such as Japan, California, New Zealand, Italy, etc., have taken steps to combat them but nothing has been done in India. He recommends that a seismological branch of one of the existing services be started and endeavour should be made to improve the standard of buildings. A simple building code should be drawn up by which new construction and town planning in India should be controlled. More detailed codes should be drawn up in accordance with local needs and enforced by Provincial Governments and Local Boards.

## BOTANY.

President H. G. Champion.

Speaking on "The Need for scientific study of India's climax vegetation", Mr. Champion says that forest growth covers about one quarter of the land surface of India, but problems connected with trees in tropical forests are almost unexplored. "Studies of light, quality, and intensity, under different types of trees and the reactions of the ground vegetation and the regeneration of overwood trees to variations in these factors are much needed. The absolute water requirements of tree crops in relation to the demands of other types of soil cover are of importance in all irrigated and dry tracts and call for investigation..... Only small beginnings have been made of the study of the tropical forest in relation to the soil though the great importance of a forest cover is now generally realised..... The consequences of the maltreatment or destruction of the forest cover provide the reverse aspect of ecological succession towards the climax vegetation..... Realisation is now rapidly spreading of the connection between denudation of forest cover and the loss of fertile soil on the slopes by erosion, the overwhelming of valuable agricultural land at the foot of the hills by gravel and boulder brought down by the torrents and the occurrence of disastrous floods in the plains".

**AGRICULTURE.**

President B. Viswa Nath.

Speaking on "Science and practice of Agriculture in India" he reviewed the progress of agricultural research in India and directed attention to some important problems. Speaking of the work on soils he referred to the scientific studies, and discussed the important differences between Indian and European soils, explained the lack of success in India of many of the results and practices found suitable in Europe and stressed the necessity of a different outlook on the applied aspect of soil science in India. He then discussed manures and fertilizers and said that evidence clearly established the importance and suitability of organic manures to Indian soils. He drew pointed attention to the evil consequence of intensive cultivation and intensive use of fertilizers without organic matter and organic manures.

**LETTERS TO THE EDITOR.****A NEW STRAIN OF MID-LATE KOLAMBA RICE.**

Mr. Kadam of the rice breeding station at Kolaba describes a new type of rice named Kolamba 540. The average yield is 2385 lb. per acre and matures early. The natural test weight of paddy of this new strain is 45 lb. per imperial bushel.

**THE NATIONAL ACADEMY OF SCIENCES, INDIA.**

At the meeting on December 21, 1936 Mr. R. N. Ghosh read a paper "On a simple derivation of Stresses in a Moving Fluid".

*No. 8—February 1937.*

**SOIL EROSION AND ITS CONTROL.**

Gorrie.

(Review of publication "Soil Erosion and Its Control" by Q. C. Ayres —).

The book under review is a students' text book written by the Professor of Agricultural Engineering in the Iowa State College, Ames, Iowa. It gives an excellent general account of the erosion situation in the United States. The reviewer states the most useful section of the book for Indian practice is that on the planning and construction of soil conservation and water storage dams. In Gurgaon, Punjab, and many other waterless tracts of isolated low hills there is a great future for water checking dams of earth or stone. Useful tables are given for calculating size of such dams and their outlets, based on run-off.

**THE INDIAN AND EASTERN ENGINEER.**

**VOL. LXXX.**

*No. 1—January 1937.*

**EDITORIAL NOTES.**

Comments on discussions at the International Committee on large dams.

**ARC-WELDED BRIDGES—A SURVEY.****Moon.**

A study of examples of various types of bridges of welded construction. Some of the advantages enumerated of this type of construction are :

1. Simplification of detail.
2. Fabrication at site.
3. New forms of deck construction and ease of ensuring watertightness.
4. Effective use in combined steel and concrete construction.
5. No projecting rivet heads—cleanness of line.
6. Easy straightening.

Welding has been applied to the construction of small span bridges of all types, and for spans upto 300 ft.

**BOMBAY ENGINEERING CONGRESS 1936 : PRESIDENTIAL ADDRESS.**

The address deals principally with various aspects of mechanical engineering in India. There is an increased desire to obtain technical and engineering education in India but the means of obtaining such education have not increased in the same proportion. There is a want of facilities for practical training. The huge wastage of coal due to inadequately trained boiler men has been referred to. The questions of cheap power for the textile industry and the relative advantages, economic and otherwise, of electric and steam power have been discussed.

**THE MAINTENANCE OF WATERWAYS TO HARBOURS AND DOCKS.****Carpmael.**

Summary of a paper read before Institution of Civil Engineers.

**THE STUDENT'S CORNER.****Antia.**

Describes the procedure of preparing a bill of quantities for an estimate.

An actual example has been worked out for a building.

**NOTES AND NEWS.**

Fireproofing of wood and paper. A new agent for fireproofing of timber, plywood, wall-boards and paper has been perfected, the basic constituent of which is mon-ammonium phosphate.

*No. 2—February 1937.*

**HYDRAULIC POWER.****Taylor.**

Some practical notes on the construction and working of accumulators.

**THE STRAND MARKET WHARF AT RANGOON.**

This is a new wharf built to connect two old wharf systems. It is built of reinforced concrete. Some idea of the magnitude of the work may be gauged from the fact that the concrete piles used are 75 ft. long, each weighing 12 tons. Over 1,300 of these piles

were driven to an aggregate length of 80,000 ft. More than  $3\frac{1}{2}$  million feet of steel reinforcement and 40,000 casks of cement were used. The front of the wharf which is subject to impact from ships consists of 42 concrete cylinders, 7 feet in diameter and 75 ft. long which after being founded were filled up with concrete and weighed some 180 tons each. Details of design and construction have been given with illustrations.

#### **A NEW SMALL EXCAVATOR.**

Describes a new small excavator the features of which are low cost and lightness. It can attain a cutting height of 23 ft., a digging depth of 16 ft. and a shovel reach of 30 ft. Besides being used as a shovel excavator, the new machine can also be employed as a grabbing excavator, dragline or skimmer, crane, pile driver and stamper for compressing soil. It is driven by a Diesel engine of 45 H. P. output.

#### **THE STUDENT'S CORNER.**

Correct methods in setting out foundations of buildings. Gives the procedure of setting out masonry buildings, and steel frame or reinforced concrete buildings.

*No. 3—March 1937.*

#### **EDITORIAL NOTES.**

##### **KINCARDINE-ON-FORTH BRIDGE.**

Some details of the longest road bridge in Great Britain are given (See page 19 of Quarterly Bulletin No. 4).

#### **RE-GIRDERING OF BRIDGES ON THE G. I. P. RAILWAY.**

A paper contributed by Mr. W. Wood to the Institution of Civil Engineers giving a brief history of the circumstances leading to the regirdering, and describing the method adopted for carrying out this work on nine single line bridges ranging from 60 ft. plate girder spans to 200 ft. spans of wrought iron multiple lattice girders. A feature of the scheme is that existing girders were removed complete, and the new girders after assembly and rivetting in the girder yard were launched into position without the use of large cranes.

#### **THE LONGEST BRIDGE IN THE BRITISH EMPIRE.**

Summary of two papers read before the Institution of Civil Engineers describing the main features of the design and details of construction of Lower Zambezi railway bridge. (See Journal of Institution of Civil Engineers, January 1937 in this bulletin).

#### **MODERN ROAD CONSTRUCTION.**

Taylor.

An article on concrete pavements of the present day. Describes construction methods and tools, expansion joints, and curing.



**THE STUDENTS' CORNER.**

**Engineering Estimates, Contracts and Specifications.** Discusses the contract method of execution of works, lump sum contracts, schedule contracts, tenders, etc., etc.

**NOTES AND NEWS.**

The Associated Cement Companies Ltd., have completed plans for erecting new factories and reorganizing existing works so as to meet the demand in India in the most economical manner. The plans comprise an up-to-date cement factory in central Punjab and one in Sind.

The increasing use of the material called ironite is evidenced by the increase in export of this material to the Far East. Ironite is principally used to provide a dense, waterproof, wear-proof, and grease-proof topping to concrete surfaces such as floors, etc. It is mixed dry with cement and clean crushed aggregate. The floor topping is usually  $\frac{1}{2}$ " in thickness. In setting, the ironite particles expand and tightly seal the pores and interstices.

**INDIAN CONCRETE JOURNAL.**

VOL. XI.

*No. 1—January 1937.*

**NEWS AND NOTES.**

The Government of Travancore have taken in hand the construction of an important bridge on the road connecting Cochin Harbour with the plantation district High Ranges. The bridge will be of reinforced concrete arch construction with two end cantilevers and will be founded on reinforced concrete piles.

**CONCRETE PATCHED BY GROUT SPRAYER.**

A device for filling bolt holes, or smoothing up gravel pockets. The gun or ejector, which is easily carried by one man, is worked by air pressure of from 40 to 50 lb. per sq. inch.

**PROPERTIES OF BREEZE AND CLINKER AGGREGATES.**

Bulletin of Building Research published by H. M. Stationery Office.  
The behaviour of breeze and clinker concrete mainly depends on :

1. Amount of combustible matter present in the aggregate.
  2. The nature of the combustible matter. 'Clinker' covers well burnt furnace residue, fused into lumps ;
- 'Breeze' includes any type of furnace residue from disintegrated clinker to ashes.

The bulletin gives descriptions of methods of testing the soundness of breeze and clinker aggregates.

**MECHANICAL CONSOLIDATION OR VIBRATION OF CONCRETE.**

W. H. E.

The object of vibration is the elimination of hand tamping with its attendant uncertainties. With hand tamping, workability can only be secured by using a mix with abundance of water. By mechanical vibration a mix may be used containing only that amount of water necessary for maximum strength. The most commonly employed method of vibration is the vibration of the shuttering. Pneumatic or electrically operated vibrators are clamped on to the outside of the shuttering. Frequency of vibration varies from 5,000 per minute to 9,000 per minute. The number and position of vibrators to be used is largely a matter of experience. Mass concrete which cannot be efficiently vibrated from outside only, can be vibrated directly through the concrete by a vibrating lever or needle. In certain cases the reinforcement itself is vibrated. Vibration is commenced as soon as filling of the shuttering is started, and should stop as soon as air bubbles cease to rise to the surface. Prolonged vibration interferes with the initial set. Vibration is a comparatively new method and expert advice is essential, otherwise failure and disappointment may result.

*No. 2—February 1937.*

This is a special number devoted to concrete Roads.

**INDIAN ROADS CONGRESS.**

The Indian Road Congress was invited by the Government of the United Provinces to hold its third meeting in Lucknow. A number of papers were presented, one of which was "A submersible bridge across Parbati River at mile 231 Agra-Bombay Road".

**TEST TRACK.**

A test track is being built at the Alipore Research Station in Calcutta. The track will be circular, 600 ft. long and on this the various kinds of wearing road surfaces can be tested out one against the other.

**CONCRETE ROADS IN THE UNITED PROVINCES.**

Haig.

Description of a number of concrete roads in the United Provinces is given with details of construction.

**CONCRETE ROAD CONSTRUCTION IN DELHI CITY.**

Chakravarti.

Describes some new concrete roads recently constructed in Delhi.

**IMPROVED JOINT FILLER.**

Engineers in the Materials and Research Department of California Division of Highways have developed what they regard as an improved filler for cracks and joints in concrete pavements. The product is a combination of bitumen and commercial rubber

latex. The product and the method employed is described in *California Highways and Public Works*, September 1936 issue.

No. 3—*March 1937.*

#### PROPORTIONING CONCRETE MIXTURES.

Reynolds.

There are three principal methods of proportioning :—

- (a) By measurement of voids.
- (b) 'Fineness modulus' method (See Bulletin No. 4 page 43).
- (c) By trial mixes.

These methods are described and the advantages and disadvantages of each are discussed. The article is to be continued.

#### CELLULAR CONCRETE BRIDGES, WASHINGTON.

Describes features of cellular or hollow-member concrete bridges, a number of which have been completed in Washington. The hollow construction is obtained by the use of internal forms built up of wood and placed within the girder forms to save concrete and cut down the weight.

### INDIAN ENGINEERING.

VOL. CI.

No. 1—*January 1937.*

#### NOTES AND COMMENTS.

##### MADRAS ELECTRICAL PROGRESS.

Comments on the administration report of the Govt. of Madras, Electricity Department for 1935-1936. The report shows satisfactory progress. The Pykara scheme earned 16.17 lakhs in the year, an increase of 61 per cent. over the previous year. The system became self-supporting with its third year of operation. Progress at Mettur was up to official programme. Government have sanctioned the extension of Pykara Power to Madura at a cost of 33.5 lakhs. Rapid progress was made with the construction of Mukurti Dam.

##### ENGINEERS' REGISTRATION.

At the annual general meeting of the Institution of Engineers, India, Bengal centre, Mr. P. N. Banerjee, Chairman, in his speech dealt with the question of registration of engineers in Bengal. The measure would permit only properly qualified men to register themselves as engineers and would protect the public from exploitation by incompetent and unqualified men.

**CURRENT NEWS.****BENGAL IRRIGATION.**

The Govt. of Bengal have sanctioned a few minor irrigation projects which are to be taken up by the District Board of Jessore. A sum of Rs. 22,073 has been sanctioned by the Govt. and one third of the expenditure will be borne by the District Board of Jessore.

**ALUMINIUM STRUCTURES : PROPERTIES OF ALUMINIUM  
ALLOYS AS STRUCTURAL COMPONENTS.**

The most popular aluminium alloy now used in construction is Duralumin and contains 4 per cent. copper,  $\frac{1}{2}$  per cent. magnesium and  $\frac{1}{2}$  per cent. manganese, the rest being aluminium. The ultimate tensile strength of structural steel is 28 tons per sq. inch. Specific gravity of duralumin is 2.79 while that of steel is 7.8 and a tie rod of duralumin would have a weight just 40 per cent. of that of the steel bar of equivalent tensile strength. Duralumin may also be used with advantage for compression members. For long struts the weight in duralumin will be almost exactly 60 per cent. of the weight of an equivalent steel strut. When used as a beam, and the resultant deflection is a matter of importance, the duralumin beam is slightly larger in section than the steel beam. The equivalent of a steel beam 6 inch by 3 inches in duralumin would be 8 in. by 4 in. to give the same deflection. The weight of the duralumin beam however would be 9.2 lbs. while that of steel would be 15 lbs.

The coefficient of expansion of duralumin is twice that of steel, but it is not necessary to provide expansion joints in aluminium structures unless such provision would normally be made for a similar steel structure. The lower modulus of elasticity of aluminium counteracts its higher expansion. Aluminium alloys are ordinarily far more resistant to corrosion than steel, and though it is not suggested that painting can be avoided altogether, the amount of such protection required is far less than with steel.

**WORLD'S LARGEST DAM.**

A description of the Boulder-Canyon project and Boulder Dam. The dam rises to a height of 727 ft. The contract was completed two years in advance of the stipulated time. The construction of Boulder city, Nevada, a government town, was the first step in the project to provide the best possible living conditions to the construction organization. The second step was the construction of four diversion tunnels 56 ft. in diameter and 4,000 ft. in length. The third step was the construction of upper and lower cofferdams by which the river was turned through the diversion tunnels and the dam site dried up. The fourth major operation was the construction of the dam and power house and the fifth and last

was the installation of the power plant. The mass concrete of the dam consisted of 1 part of cement to 10 parts of sand gravel and cobbles. Nine inch stones were the largest used. This concrete was carried in steel buckets with a capacity of 8 cubic yards and weighing 20 tons each when filled. One of the major problems connected with construction of the dam was the removal of the excessive amount of heat generated in the concrete during the process of setting. It was estimated that if no special steps were taken to remove this heat it would require about 150 years to cool down to its final temperature. About 570 miles of 1 inch steel pipe for cooling were used in the refrigerating plants which cooled the cement.

#### MODERN MARBLE MARVELS.

A special type of marble named "Lumar" has been found recently. It is a highly translucent stone which retains the same glistening sparkle in transmitted light that marble exhibits by incident rays. It is an excellent material for illumination and building purposes.

*No. 2—February 1937.*

#### CURRENT NEWS.

**Marala Weir.** In conjunction with irrigation projects in the Punjab one of the most important is the reconstruction of the Marala Weir at an estimated cost of Rs. 15 lakhs which will add greatly to the safety of the weir and reduce the bills for maintenance.

#### INDIAN IRRIGATION WORKS.

Editor's comments on the Annual Report of the Punjab Irrigation Research Institute at Lahore published in January 1937.

#### UNITED PROVINCES POWER EXTENSION.

The Govt. of the United Provinces have had under consideration for some time further applications for the generation and distribution of electricity in the light of the remarkable developments that have taken place in regard to bulk supply during the last 7 years. Local bodies are at an inevitable disadvantage as distributors of electricity within their jurisdictions and this fact has led Govt. to the conclusion that it will be inadvisable to grant distributing licenses to such bodies. Experience has shown that local distribution can be most profitably entrusted to reliable electrical companies who employ technically qualified and competent staff. Further individual urban generation of electricity will be an obstacle in the development of agricultural pumping in the rural areas round the towns. Govt. have satisfied themselves that provided certain concentrated irrigation pumping loads are available at stations located on the Eastern rivers it is possible to connect these stations with a high tension network to furnish power at intermediate towns at rates which would facilitate development of minor industries.

**NOTES AND COMMENTS.**

**Allahabad District Irrigation :** As a result of a survey to find a suitable site for pumping water for irrigating the western parts of Allahabad district in the U. P., a site on the Tons river has been discovered where the lift is about 40 ft. It will be possible to serve a large tract of area from this site as well as to produce electricity for village industries at a cost not greater than that in the Ganges hydro-electric grid area. It is considered that the Government will take early steps to bring this scheme into action.

**U. P. Irrigation :** The revised Ganges Canal hydro-electric grid project sanctioned by the Secretary of State for India provides for seven canal power stations yielding 18,900 kilowatts and a steam station with a capacity of 9,000 kilowatts. Four canal power stations were completed some time ago and two are in progress. The total number of completed wells up to 31st March 1936 was 743.

**Indian Roads Congress :** The third meeting of the Indian Roads Congress concluded its session at Lucknow on February 24th, 1937. Mr. S. G. Stubbs, I.S.E., Superintending Engineer, Punjab was elected President for the ensuing year.

**INDIAN ROAD PROBLEMS.**

His Excellency Sir Harry Haig, Governor of United Provinces in the course of his speech at the opening of the Indian Roads Congress at Lucknow on February 22, 1937 stressed the importance of the Indian Roads Congress, and said that the existence of a technical body concerned with the advance of road engineering technique is essential. It is the paucity of financial resources which make research into road methods a matter of the most vital importance. The problem is to evolve metalled and unmetalled surfaces suitable to modern traffic conditions at materialy lower levels of cost than now prevail.

The President, Rai Bahadur Chhuttan Lal in speaking of earth roads said that they are of vital importance in the economic life of the country and their improvement will play an important part in rural development. The problem is a difficult one and in its technical aspect is partly of soil research and partly of the bullock cart wheel. The Govt. of India are being approached for funds for research in soils and other experiments.

**SHEET STEEL PILING.**

Lewis.

The article describes a few types of modern sheet steel piles and their uses in trenches, cofferdams, building foundations, bank protection in canals and rivers and water exclusion. The Johnson pile driver is also described.

## BENGAL ROADS AND BRIDGES CONSTRUCTION.

Mentions a number of bridges proposed to be built in the near future in Bengal. The Govt. of Bengal have arranged for the construction of a test track at Alipore on which will be reproduced actual working conditions of roads throughout India under varying weather conditions as affected by pneumatic, solid rubber and steel tyres. The properties of soils dependent on moisture change and loading are being investigated.

## AGRICULTURE AND LIVE-STOCK IN INDIA.

VOL. VII.

*Part I—January 1937.*

### SOME METHODS OF SOIL MANAGEMENT.

Bal.

Indian soils are deficient in organic matter. Easy methods of increasing organic matter are :—

- (1) Addition of various waste material such as dry leaves, old thatching material, inedible fodder, stalks of cotton, etc., in the form of compost.
- (2) Material known as 'gutterfly', which is the residue obtained when cotton bales are opened and passed through the blower, has been found to be very valuable as organic manure. This material is available in large quantities from cotton spinning and weaving mills.
- (3) Green manuring.
- (4) Human excreta or night soil if efficiently utilized as a manure would prove of immense value in enriching the soil.

One more important method of conserving soil fertility is the practice of proper rotation of crops. Artificial manures are useful in supplying nitrogen, phosphorus and potash. Ammonium sulphate and nitrate of soda are generally used for this purpose. Potassic fertilizers are useful for sugarcane. The soil should also contain the right proportion of moisture and air. Regulation of soil moisture is achieved by reducing to the desired extent the excess of water in the soil by surface drainage etc., and by artificial watering where the soil is deficient in moisture. When water from a well is used for irrigation, the water should always be examined for its suitability. Continuous use of water containing harmful ingredients may spoil the soil to a considerable extent.

### A PRELIMINARY NOTE ON THE POSSIBILITIES OF BREEDING NEW VARIETIES OF SUGARCANE UNDER NORTH BIHAR CONDITIONS.

Khanna.

Bihar conditions have always been considered too severe to enable cane to produce fertile flowers. The possibilities of breeding sugarcane varieties under Bihar conditions have been for the first time

demonstrated. Uniformly good results have been obtained under conditions of controlled temperature and humidity. The experimental work carried out and the results obtained are described in detail.

#### REVIEWS.

**THE USE AND MISUSE OF LAND :** Oxford Forestry Memoirs No. 19, 1935, by R. Mc Lagan Gorrie. D. Sc. (Review by Dr. E. McKenzie-Taylor).

The book gives an excellent account of researches on soil erosion control that have been carried out in the United States. The work has been admirably planned to bring out the relation between forestry in the hills and agriculture in the plains. As a result of Dr. Gorrie's researches the way is now clear for an attack on erosion problems in India. Methods of investigation are available, methods of control of erosion have been devised and it remains now for these methods to be applied. The importance of forest cover in the hills on both the surface and underground water in the plains is not fully realized. The fall in the subsoil water table in Jullundur area is attributed to the overgrazing of the Siwaliks. High peak flood discharges in many rivers may be attributed to the same cause. Recently, attention has been drawn by Dr. Church in America to the effect of forest cover on snow accumulation—an important problem connected with river supplies in April and May in Northern India. (See also Bulletin No. 2 page 45).

#### THE INDIAN JOURNAL OF AGRICULTURAL SCIENCE.

VOL. VI.

*Part VI—December 1937.*

**AGRICULTURAL METEOROLOGY :** Studies on soil-moisture in relation to moisture in the surface layers of the atmosphere during the clear season at Poona. Randas. Katti.

**STUDIES ON SOIL-MOISTURE.** Movement of soil-moisture under field conditions. Carbery. Chakladar.

The conditions of soil moisture at varying depths have been studied in the farm at Dacca during the dry season, and it has been found that loss of soil moisture is greatest and very rapid in the first three inches, and then gradually decreases up to a depth of 18 inches, beyond which there is an equilibrium moisture zone which remains at the same moisture content to the end of the dry season.

The phenomenon of capillary rise has been discussed and it has been shown that the upward movement of water in soils starts from the surface and gradually goes down.



**MINERAL MATTER IN THE JUICE OF SUGARCANE AND ITS EFFECT  
ON THE RECOVERY OF WHITE SUGAR, I.**

**Lander.  
Ramji  
Narain.**

Sugar refineries in the Punjab have always shown a preference for 'gur' from United Provinces over the local 'gur', on the plea that the former yields a greater percentage of white sugar. As a result of various analyses it was found that the 'ash' or mineral matter present in the raw sugar prepared from United Provinces 'gur' is less than that present in the Punjab 'gur'. This fact led to a systematic enquiry being undertaken into the causes responsible for the high 'ash' content of the Punjab 'gur'. The results of the investigation are presented in this paper. The conclusions arrived at are that the composition of the Punjab soils is responsible for the high mineral content of the cane juice. It has been shown that in mechanical composition and the nature and amount of their water and acid-soluble salt content the sugarcane soils of the United Provinces and Punjab are similar, but they differ in the amount of exchangeable calcium, and the Punjab soil has a slightly higher pH value. This seems to be the most likely explanation of the higher mineral content of the Punjab cane juice. Experiments are in progress to see if it is possible to modify the mineral content of the juice by treatment of the soils with certain manures and chemicals.

**THE PROBLEM OF THE NITROGEN SUPPLY OF RICE.**

**Pran  
Kumar Sm. C.**

Large rice crops are produced in many parts of India on the same land, year after year, without any apparent loss of yield although no manure is applied to the land. The constant drain of nitrogen is not made up by import of manure. It follows that the soil must obtain supplies of nitrogen from somewhere, otherwise the crop would cease to grow. The only likely source is fixation from the atmosphere and the question arises as to how this takes place. It is also possible that the plants themselves are able to assimilate elementary nitrogen like legumes. Sen in 1929 demonstrated the occurrence of nitrogen fixing organism within the rice root, and Viswanath in 1932 obtained indications that rice plants may possess the power of fixing nitrogen. Experiments to study the problem were started in Dacca in 1931, and the paper embodies the results of these experiments. The results may be summarized as below :—

- (1) Several rice soils collected from different parts of India were studied. Fixation of nitrogen took place in all the soils when they were waterlogged and exposed to sunlight for 3 months.
- (2) Soils with slightly alkaline reaction fixed much more nitrogen than those less alkaline, and in the case of the former, a heavy algal growth appeared soon after waterlogging.

- (3) From the evidence available it is concluded that the fixation of nitrogen in waterlogged soils is an algal process, though it is yet to be decided whether the fixation is brought about by algae alone or in conjunction with other organisms.
- (4) Bacteria fix more nitrogen in the dark than in sunlight.

## SCIENCE AND CULTURE

### VOL. I.

*No. 1—June, 1935.*

#### BENGAL RIVERS AND THEIR TRAINING.

Bose.

Bengal is a land of mighty rivers. The Ganges at the Hardinge Bridge carries 20 million cusecs of water during floods. The Brahmaputra carries one and half times as much. These enormous quantities of water flowing over soft alluvial soil cause annual floods and erosion of river banks. Sometimes the floods become catastrophic, sweeping away homesteads and cornfields and causing much distress. The writer dwells on the changes in the courses of the Bengal rivers during the last three hundred years and considers that the remedy of the erosion and trouble caused by the floods lies in restoring the river systems to their old courses. He gives a brief account of the Mississippi Flood Control Scheme and the scheme of the Miami Conservancy District and points out that enormous savings were effected in the flood detention reservoirs of the Miami District as a result of laboratory research. He describes some hydraulic laboratories in Europe where experiments on rivers are being carried out such as Prof. Rehbock's at Karlsruhe, Prof. Gibson's at Manchester, and that at Charlottenburg, Berlin. A few experiments for India were being carried out in some of these laboratories under commission from construction engineering companies. Government Departments in India are realizing the value of model experiments and there are laboratories in the Punjab, Bombay, and Sind but there are none in Bengal. To deal with the flood problem of Bengal—"What is necessary is to examine the river system as a whole by a thorough surveying and levelling for a number of years and to collect all old available hydraulic data of the rivers. Meanwhile a scheme for a river training laboratory can be prepared and a laboratory started near Calcutta to investigate the problem".

### VOL. II.

*No. 8—February 1937.*

#### SOME PLANT DISEASES AND PESTS OF INDIA AND THEIR CONTROL.

Mitra.

Plants, like human beings and animals are liable to disease. As an example of the loss to the country from plant diseases it may be

mentioned that the annual loss to India due to a particular disease, rust of wheat, is more than 4 crores of rupees. Symptoms of various plant diseases, the agents responsible for these diseases and the control measures to be adopted are discussed.

## THE MADRAS ENGINEERING COLLEGE MAGAZINE.

VOL. V.

*No. 1—October 1936.*

### IMPACT ON RAILWAY BRIDGE GIRDERS.

Vasudevan.

In this article an attempt has been made to describe the effects of impact on railway bridge girders, bereft of intricate mathematics. The causes of impact have been enumerated, and the covering formula recommended for adoption in designing new girders has been given. The formula takes into account all the causes of impact enumerated.

### JOIST CONCRETE FLOOR.

Desai.

Shahani.

An article on the design of joist concrete floors. Includes a study of comparative costs of the joist concrete and R. C. slab types of floors. The article is supplemented by a number of tables which are helpful in design.

### DESIGN OF OFFICE BUILDING.

Sadarangani.

Detailed design of a typical office building of the steel frame type, the outer walls being of brick. The floor is of planks on R. S. joists.

### SUBSOIL DRAINAGE.

" Viator "

(Reprinted from Road and Roads construction.)

Discusses the value of subsoil drainage as a means of foundation stability. There is a lack of scientific data concerning the effect of moisture upon the strength of different types of soil and the nature of the movements of water in the pores. Research in this direction is being done. To determine the precise value in a particular circumstance is difficult but to make correct inferences, some knowledge of general properties of soil is essential. The character of clay is then discussed, and the nature of movement of water in mass clay and in other soils are set forth. The inference drawn is that subsoil drainage may perform a useful function even in soils which at first sight appear to offer the least promise of success. The procedure of examining a site with a view to decide the type of drainage required is described in the concluding portion of the article.

## REVISTA DE LA SOCIEDAD CUBANA DE INGENIEROS.

(In Spanish.)

VOL. XXX.

*No. 1.—January 1937.*

TRANSLATION OF THE INAUGURAL ADDRESS OF DR. KARL TERZAGHI AT THE  
INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION  
ENGINEERING.

NEW ARITHMETIC FROM INFINITESIMAL CALCULUS.

Corral.

*No. 2.—February 1937.*

Nothing of interest to irrigation engineers in this issue.

## IRRIGACION EN MEXICO.

(In Spanish.)

VOL. XIII.

*Nos. 3 and 4.—September and October 1936.*

FILTRATION IN EARTHEN DAMS: ITS INVESTIGATION  
THROUGH THE MEDIUM OF HYDRAULIC MODELS.

Mercado.

This describes experiments with a model in a glass sided tank; also  
methods of taking soil samples, tests for permeability, etc.

OBSERVATIONS ON THE CULTIVATION OF THE POTATO IN  
THE STATE OF TLAXCALA.

Pena.

This article deals very fully with the production of potatoes, yields,  
species, diseases, costs, etc.

PRELIMINARY AGRO-ECONOMIC INVESTIGATION OF THE  
IRRIGATION PROJECT ON THE TARECUATO RIVER,  
MICHUACAN STATE.

Rico.

ASI ES.

el Mexico de hoy y de manana.

(In Spanish.)

*Irrigation.—No. 6.—1936.*

A brochure of photographs of large irrigation works in Mexico.

## CIVIL ENGINEERING (NEW YORK).

VOL, 6.

*No. 11.—November 1936.*

EARLY WORKS OF THOMAS TELFORD, ENGINEER.

Baker.  
Armitage.

This article deals with Telford's early life and works. His reputation  
as an engineer was established by the construction of the 112

mile long Ellesmere canal. He also built two aqueducts, the first consisting of ten arches of rubble masonry with 40 ft. spans. The gap to be bridged was 710 ft. wide. In the second case the gap was 1005 ft. This he built of cast iron arches 19 in number having a span of 54 ft. each.

#### CORRELATING GROUND AND AIR SURVEYS.

Lambert.

The article describes how maps are made from aerial photographs by use of stereoscope and ground control. Aerial photographs are subject to errors of horizontal displacement due to varying distances from the photograph centre, differences in elevation and other less important factors. The whole process of making accurate planimetric maps from air photographs hinges on the art of recognizing the various displacements of the photographic images and applying the proper correction. Modern stereoscopic plotting methods enable the experienced aerial surveyor to produce an entire topographic map, contours and all, direct from photographs of the covered area. A stereoscopic type of plotting machine is used for producing small scale models of areas photographed.

For economical results, the correlation between ground work and photogrammetric work in any survey should be properly proportioned.

#### MODELS GUIDE WORK ON WESTERN DAMS.

##### 1. EXPERIMENTS AID IN DESIGN AT GRAND COULEE.

Warnock.

##### 2. USE OF MODELS AT FORT PECK DAM

Hathaway.

The major problem in connexion with the design of the proposed overfall spillway of the Grand Coulee Dam was that of protection against scour at the toe. Four different models were tested to develop a method of protection. The first model was to a scale of 1 : 184 and the design evolved as a result of experiments with this model consisted of a bucket shaped apron with a dentated lip on the downstream edge. A second model was constructed to a scale of 1 : 40 to study in detail the action in the bucket. A third model to a scale of 1 : 15 was constructed for comparison of data with the second model. To test the action of the proposed bucket in its entirety a complete model on a scale of 1 : 120 was constructed including spillway, power houses, tailraces, and a half mile of the river bed below the dam. Investigations on this model were made on the erosion of the river bed, the spillway training walls and the spillway crest. Other model studies include studies on a model of the west cofferdam area to assist in the preparation of diversion plans, efficiency tests on model of a turbine and studies to assist in the design of sluiceways and control gates.

Several models were employed in the design of Fort Peck Dam. Hydraulic model studies were made of the spillway, one tunnel and the control structures, the complete tunnel outlet works, and the

dam proper. All these models are described and discussed in detail. The articles are accompanied by several photographs of models and plans.

#### GROUTING BOULDER DAM TUNNELS.

Minear.

Approximately 235,000 cu. ft. of cement for grout were used in grouting 22 of the tunnels and their appurtenant works. Eighty per cent. of this grout was injected through the walls of the 50 ft. diversion tunnels. The mechanical equipment of the portable grouting plant, and the principles underlying the work are described in detail in this article. Neat cement grout was found to be the best. High pressure grouting was an important factor. The grouting procedure adopted is described. The method of closing shrinkage cracks, and contraction joints is explained in detail.

#### MODEL TESTS OF OUTLET TRANSITIONS.

Benson.

The function of an outlet transition is to transfer swiftly moving water from a flume or syphon to a larger channel usually of earth in which the velocity is low. The experiments described in the article were made to study the flow through a carefully designed transition, and to develop if possible a satisfactory transition that would be simple and cheap to construct.

#### A DEVICE FOR PRECISE MEASUREMENTS OF ORIFICE DISCHARGE.

Yasines.

Describes an apparatus designed by the writer which incorporates a pitot tube to determine the coefficient of velocity and a device to measure accurately the diameter of the constricted section of the jet.

#### COMMENTS FROM READERS.

Comments on Manual No. 11 of the American Society of Civil Engineers "Letter Symbols and Glossary for Hydraulics". Definition of the term "conjugate" applied to depths before and after the hydraulic jump is not given in the manual. A new definition of "hydraulic jump" is suggested.

#### CURRENT PERIODICAL LITERATURE.

*Welding Engineer*, June 1936. Welding construction in steel cofferdam, arc welding repairs of worn bucket teeth, etc., are features of the construction work at the Grand Coulee Dam.

*Revue Universelle des Mines*, March 1936. Contains theoretical discussions of designs of foundations on elastic ground for walls, locks, columns, etc.

*Annales de l'Institut Technique*, Vol. I, Jan.-Feby. 1936.—Gives review of systematic study of foundation soils in France. Review of theory of earth pressure, description of testing apparatus for measuring internal friction, cohesion, compressibility and permeability of soils, studies of dam foundations.

*Construction Methods*, May 1936. Description of equipment and methods used for concrete lining of Colorado River aqueduct canal 62 miles long having water depth of 10·2 ft. and top width of 57 ft. Accurate trimming of bed and sides of excavated canal by mechanical subgrader and vibrating of concrete lining are described.

*Wasser-u. Energiewirtschaft*, Vol. 27, Nos. 7 and 8, July-August 1935, Sept.-Oct. 1935. Review of silt and erosion control, improvement of torrential mountain streams by check dams and other methods.

*No. 12.—December 1936.*

CONSTRUCTING THE CALEDONIAN CANAL AND OTHER CANAL  
WORKS OF THOMAS TELFORD SUBSEQUENT TO THE  
YEAR 1800.

Baker.

Armitage.

This is in continuation of the article published in the November issue. After the construction of the Ellesmere canal, Telford turned his genius to the construction of the Caledonian Canal. This canal is 200 miles long and extends across Scotland from the North Sea to the Atlantic, and includes 22 miles of artificial channel. The cross section is trapezoidal. The bed width is 50 ft., top width 120 ft. and depth 20 ft. Telford next designed and constructed a  $2\frac{1}{2}$  mile tunnel through Harecastle Hill to carry the Trent and Mersey canal. Later he was called to Sweden as consulting engineer on the Gotha canal construction. The main problems and the manner of dealing with them are described. Several plans and cross sections are included.

BEACH EROSION IN SOUTHERN CALIFORNIA.

Cram.

Beach erosion along the southern coast of California constitutes a serious problem. The beaches are dependent for existence on the supply of detritus delivered by rivers and streams. As a result of the construction of numerous irrigation and flood control works along these rivers the supply of beach sand is diminishing and erosion control works have therefore become necessary. The phenomena affecting widths of beach backshores are wind, waves, tides and sand supply. Of these the first three are unchanged and the last has been basically modified during recent years. The backshore widths are continually diminishing. Protection by artificial works is thus necessary.

GROUTING THE FOUNDATIONS OF BOULDER DAM.

Jones.

Minear.

Three different series of holes were made for grouting the foundations of Boulder Dam. These are shallow low pressure holes under the upstream part of the dam; deep high pressure holes forming a main grouting curtain under the axis of the structure; and high

pressure holes of intermediate depth forming a supplementary grout curtain under the upstream heel of the Dam. The field procedure used and the results obtained in grouting these holes as well as others located under the spillways, weirs, intake towers, and rock abutments are described in this article. Certain conclusion as to best materials, equipment and procedure for grouting were reached, which will be of value in future work of the same type.

#### FREEBOARD FOR WATER-IMPOUNDING STRUCTURES.

Wolf.

A logical method of determining freeboard which takes into account both the fetch and the maximum wind velocity is presented in this article. The method was developed by the writer following a review of technical publications on the subject, a theoretical analysis and an investigation of a number of existing reservoirs. The method consists of using a modified formula evolved by the writer, to estimate the highest waves above maximum flood water surface, and add a substantial amount for ride-up and wind spray.

#### A SYSTEM FOR FILING TECHNICAL LITERATURE.

Lane.

Describes a scheme of classification and filing of technical periodicals evolved by the writer.

#### COMMENTS FROM READERS.

##### COMPOSITION OF FORT PECK FILL.

Certain other details of the work of placing hydraulic fill at Fort Peck are given by Mr. T. A. Middlebrooks. The original article was published in the October issue. (See Quarterly Bulletin No. 4 page 49).

#### ITEMS OF INTEREST.

A unique large scale hydraulic laboratory is being constructed by the University of Minnesota on the Mississippi River at St. Anthony Falls. There is a head of 48 ft. available at this site. Arrangements are being made to handle a discharge of over 300 cusecs at the laboratory. Other details as regards dimensions of experimental rooms are given.

VOL. 7.

*No. 1—January 1937.*

#### SOIL MECHANICS IN HIGHWAY CONSTRUCTION.

WOODS.

Describes the following:—

1. The Proctor test for controlling moisture and checking the compaction of embankments.
2. Shear and consolidation apparatus for testing foundation soils to obtain the bearing capacity and estimate the rate and magnitude of settlement.



3. Classification for use in identifying subgrade soils from the stand point of anticipated performance.

#### THE DEVELOPMENT OF HIGHWAY BRIDGES IN OHIO.

Smith.

Describes the various stages of progress of bridge building in Ohio.

#### THE DURABILITY OF CONCRETE.

Mattimore.

Durability depends on the following factors : aggregates, cement, water, mixing, placing and curing. The many different conditions of exposure also form an important element in determining durability. Aggregates should be specially tested for porosity or absorption in case of dams and other structures subject to action of water. The sodium sulphate soundness test for coarse and fine aggregates is gradually being adopted for concrete subjected to sulphate action. In this test thin panels of neat cement are suspended in a ten per cent. solution of sodium sulphate. To emerge successfully from this test the specimens must remain in a normal condition without warping or disintegration for a given period. Ordinary Portland cement will not make concrete durable enough to resist sea water, mine water, drainage and other liquids containing sulphates which may subject concrete to acid action. Recent researches in special cements are now being conducted to produce modified cements to stand the above action.

#### RECENT EASTERN FLOODS AND THE NATIONAL ASPECTS OF FLOOD CONTROL.

At the Pittsburgh meeting of the American Society of Civil Engineers held in October 1936 eight papers were read under the auspices of the Waterways Division on flood control problems. These papers will be published in the March 1937 issue of the Proceedings of the Society. Digests of these papers have been given in the present article. The direct damages due to the March 1936 floods in the Eastern States amount to \$ 300,000,000. As a result of this devastating flood, the Flood Control Act of 1936 was passed and the Act provides for federal participation in flood control. The first two papers stress the legal arguments for the responsibility of the Federal Government in flood protection. A strong argument is that the United States owns the rivers and has paramount jurisdiction over them. The United States therefore should not permit this property to damage citizens of any section. A further reason is the jurisdiction of the United States over inter-state commerce. Federal control of streams is absolutely essential because a satisfactory policy cannot be developed under the present conditions. Development of a national flood protection policy conjointly with the policy governing water resources in general is essential. The varied experience of agencies at present engaged on river control work such as TVA, Corps of Engineers on Mississippi Flood Control work, and

the Muskingum group, discloses a gradual evolution towards the idea of multiple uses of streams and joint federal and local participation in tackling river control and flood protection problems.

Coming to the economic aspects of flood control, the Flood Control Act of 1936 provides that the Federal Government may participate in flood control if the lives and social security of the people are adversely affected. Thus, the construction of flood control projects on a purely monetary basis is a thing of the past.

#### STATE SYSTEMS OF PLANE CO-ORDINATES.

Abstract of two papers presented before the American Society of Civil Engineers at Pittsburgh. The papers describe the theory of the plane co-ordinate system of map making as recently developed by the U. S. coast and geodetic survey. There are also 3 publications of the U. S. coast and geodetic survey on the subject.

#### ECONOMICS OF ENERGY GENERATION.

Abstract of a number of papers presented at the meeting of the American Society of Civil Engineers in Pittsburgh. Energy Generation by Heat Engines: This paper deals with the advances in heat engines and the thermal efficiency of steam plants.

Hydro-Generation of Energy: This deals with the progress in the generation of energy by water power. Improvements in turbine design, the use of stainless steel for parts subject to mechanical wear and erosive action, use of welded steel construction in place of steel castings for guide vanes and the development of water lubricated rubber lined bearings are amongst the chief advances mentioned. Improvements in energy utilization; cost of generation of energy; economic aspects of cheap power; and electric power in economic perspective, are the titles of the other papers read and discussed.

#### STREAM POLLUTION IN THE OHIO BASIN.

The present status of pollution control and plans for future development are discussed in papers presented at the meeting of the American Society of Civil Engineers on October 15, 1936.

#### FEASIBILITY OF STORAGE IN THE WILLAMETTE VALLEY. Fox.

Lt.-Col. Fox in a letter to the editor says that a storage reservoir in the valley is economically feasible because such a reservoir may be utilized for flood control, navigation, power, irrigation and stream purification. In the Mississippi valley and States bordering the Atlantic, floods may be expected at any time of the year. For this reason a reservoir in this tract constructed for flood control, cannot function for any other purpose. In the Willamette valley floods occur in winter and low water prevails during summer. Reservoirs built for flood control in this

tract may be filled by the rains and melting snow of spring after being kept empty in the winter. The water stored in spring is available for irrigation.

#### HYDRAULIC SYMBOLS SUBMITTED BY SOCIETY COMMITTEE FOR DISCUSSION.

The American Society of Engineers' special sub-committee have adopted a list of symbols for use in hydraulic laboratories with particular attention to open channel work. The symbols have been reproduced for discussion, and comments on the symbols are invited.

#### ITEMS OF INTEREST.

##### FIRST ORGANIZED IRRIGATION IN COLORADO.

Liew.

Traces the early history of highland irrigation in Colorado dating back to 1870 and mentions the earliest reservoirs built for storage and irrigation. Illustrated.

#### *No. 2—February 1937.*

##### DRAINING THE GREAT FENS.

Baker.

Armitage.

This is the third of a series of articles on the life and works of Thomas Telford. He was the first to put into effect a rational and effective method for draining the Fens. The article describes his work in the Fen area, other works in connexion with the diversion of the river Ouse, and improving the outfall of the river Nene.

##### PREDICTING STAGES FOR THE LOWER MISSISSIPPI.

Lane.

The article describes a method evolved for correct prediction of stages in the lower Mississippi from stage observations in the higher reaches. The method is based on the use of 'stage relation diagrams'. The basis of the method and its applications are explained. Modifications required in the vicinity of large tributary streams, and the procedure for determining gauge reduction due to crevasses are given special consideration.

##### GROUTING CONTRACTION JOINTS AT BOULDER DAM.

Hays.

In order to avoid cracks due to shrinkage in the concrete, the Boulder Dam was constructed in rows of columns whose vertical joints took the place of such cracks. These joints were grouted under pressure to unite the columns into a monolithic structure. The methods and equipment used are described in this article. The effectiveness of the work was tested by core borings.

#### COMMENTS FROM READERS.

Mr. E. Totti in a letter to the editor comments briefly on the subject of designing reinforced concrete structures. The writer says

that better designs are obtained by using bars of small section of the necessary steel area, than bars of large section. Vibrations are transmitted with less intensity if the bars are small. Other advantages of small bars are less capacity of heat transmission, larger bond area, easy placing and bending, etc.

Mr. Haselton comments on the article "Filing Technical Literature" published in the December issue. He describes his own method of filing and where it differs from the method in the original article.

#### Books.

"Improvement of the Lower Mississippi for Flood Control and Navigation", 3 vols.

Summarizes one hundred years' cumulative study and experience on the Mississippi.

"The Mechanics of Turbulent Flow" by Bakhmeteff.

### CURRENT FARM ECONOMICS, OKLAHOMA.

#### VOL. 9.

##### *No. 3—June 1936.*

Discusses current prices, wheat production prospects, cotton crop produced and financial aspects of co-operative ginning of cotton.

##### *No. 4—August 1936.*

Discusses the economic situation in the State with respect to business and agriculture, and factors associated with the profitableness of some farms. Index of current prices is given.

##### *No. 5—October 1936.*

A map of drought areas of the State is given and the effect of drought on farmers is discussed. Oklahoma farm prices are discussed. Cotton situation, wheat situation, and agricultural situation in general are discussed and index of current prices given.

##### *No. 6—December 1936.*

Outlook for demand and prices in 1937 are discussed. A study of labour requirements on country farms is made and index of current prices is given.

## ENGINEERING NEWS—RECORD.

VOLUME 117.

*No. 22.—November 26, 1936.***EAST BAY CROSSING OF THE BAY BRIDGE.**

Purcell.  
Andrew.  
Woodruff.

Describes the East Bay crossing of the San Francisco-Oakland Bay bridge. This steel structure includes longest and heaviest cantilever in the United States which is supported on tall towers and anchored at only one end. Earthquake stresses were taken into account in the design of the superstructure. Fabrication, erection of the truss span and of the cantilever by derrick traveller have been described.

**FIRMING UP SOFT SHOULDERS WITH COTTON.**

A new procedure developed in Rhode Island for stabilizing sand shoulders on highways and redressing tar roadways with a cloth and bitumen armour coat. The road is of gravel surface treated with tar. The shoulders were left untreated and being very sandy, have been a very serious traffic hazard. The method of treatment was to apply  $\frac{1}{2}$  gallon per square yard of cut back asphalt to the sand and then to lay the cloth, after which the cloth was given a sprinkling of  $\frac{1}{4}$  gallon per square yard of the same cut back asphalt and a liberal coating of sand. The cloth was spread from a spool on a truck. The travel surface treatment experiment was carried out on a road consisting of 8 inches of gravel built in two courses, the bottom course being 5 inches of gravel and the wearing course 3 inches of graded gravel. The top course was treated with  $\frac{3}{4}$  gallon per square yard of 13-18 tar. Over this was placed an open weave fabric with 8 threads to an inch. The fabric was  $4\frac{1}{2}$  feet wide and was rolled out longitudinally by hand. Four strips covered 16 feet of the road. The fabric after being laid was covered with  $\frac{1}{8}$  gallon per square yard of 25-38 tar. This was immediately sanded lightly with 10-12 lb. of sand per square yard. After the sanding another  $\frac{1}{8}$  gallon per square yard of the same tar was applied and covered with 20-25 lb. of sand per square yard and no further treatment was applied.

**BETTER FLOOD FORECASTING AND FLOOD WARNING NEEDED. Turner.**

The writer says that though many projects of flood control are under consideration, a matter of paramount importance namely unified adequate flood forecasting and warning service, is not receiving attention. The proper operation of flood control works will always be dependent upon timely and accurate flood

forecasts. He thinks that flood control projects should justify themselves on flood control alone by the saving of life, property, and suffering of those affected. For flood forecasting a qualified hydrologist should be attached to the weather Bureau in each drainage system. An adequate gauging system is necessary for forecasts.

#### CURRENT NEWS.

##### HUME RESERVOIR IN AUSTRALIA COMPLETED.

On November 20, water was released through the outlet valves of Hume reservoir on Murray river in Australia. It will store 2,000,000 acre feet and create a 60 square mile lake. It is of the earth fill type with reinforced concrete core. It is 5200 feet long and 138 feet high. The upstream slope is paved with concrete blocks laid on 6 inches of gravel and the downstream side is faced with gravel 4 inches deep. The spillway is designed for a maximum flow of 8000 cusecs. There are 7 outlets 3 of which will be used for a hydroelectric plant generating 40,000 kw. The outlets are controlled by Stoney gates and 7 feet 6 inches needle valves. All outlets discharge into a concrete stilling pool with a depth of 22 ft.

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*No. 23.—December 3, 1936.*

##### THE TENNESSEE RIVER EXPERIMENT.

The Tennessee Valley Authority was created in 1933. This was the first attempt ever made to control and utilize a large river for the benefit of the surrounding region. The Tennessee Valley Act specifically empowered the Tennessee Valley Authority to build dams that would provide a 9 feet channel in the river, maintain the necessary water supply for navigation, and would control destructive flood waters in the Tennessee and Mississippi.

The authority was further directed to produce fertilizer at Muscle Shoals and was given the right to acquire or build power houses and transmission lines as well as navigation projects and incidental works. The Authority started the construction of 9 dams to cover the 500 feet range in height of the Tennessee river from its head above Knoxville to its mouth, for regulating the flow of the river and for navigation. Work accomplished so far by the Authority may be briefly stated as follows: it has designed and built dams and power houses; made rainfall and riverflow studies; surveyed land and waters; studied soil erosion and forest conditions; operated forest nurseries; sold power from several dams to municipalities; has produced fertilizer and distributed it to individual farmers. The many problems faced by the Authority in constructing the dams, complicating factors and obstacles met with are described in detail.

## USE OF SOIL STUDIES IN ROAD WORK EMPHASIZED AT RESEARCH MEETING.

At the annual meeting of the Highway Research Board held in Washington in November 1936, the progress in soils and materials research was outlined in a number of papers. The subjects dealt with are: Physico-chemical testing of soils; discussion of film action on soils; essentials of soil compaction; expansion properties of soils and soil swell tests as performed by Kansas Highway Engineers. Soil swell it may be mentioned is directly associated with warping of concrete pavements. Other papers on road stabilization and experimentation with cement and tar as stabilizing material were also read.

A paper on treatment of soils in small dams calls for particular attention. The paper brings out the successful application of stabilization processes to very small dams. The height of the dams ranges from a few feet to 65 feet and the storage capacity will average less than 100 acre feet. The usual laboratory tests have been conducted for determining the permeability, etc. Selection of suitable soils for embankment use has been guided by laboratory tests for grading, density, plasticity, stability, etc., Simple field laboratories were set up for mechanical analyses and moisture content tests as established by Proctor.

## CONSTRUCTION EQUIPMENT AND MATERIALS.

Vibrator for concrete pavement: A device to permit internal vibration of concrete in pavement construction has been developed. The unit may be attached to any type of finishing machine. It consists of a 4 inches steel pipe spanning the width of the pavement to within 3 inches of the side forms. Upon this pipe is mounted an electric vibratory motor powered by a portable gas-electric generating unit mounted on the finishing machine.

*No. 24—December 10, 1936.*

## DAM BUILDING REACHES A CLIMAX.

Sutherland.

The writer thinks that we have reached what appears to be the climax or at least a definite peak in the era of dam building in the present decade which marks the completion of Boulder Dam, and the approaching completion of Fort Peck Dam and the Grand Coulee Dam. It would therefore be of interest to review this period setting down the principal characteristics of the major structures. In the review the writer has considered dams over 100 feet high.

The gravity dam of a century ago was of unscientific section. The use of rubble and cut stone masonry has given way to the use of concrete. Placing methods have changed and the latest method of bucket placing from cableways has been developed. Other

improvements are use of contraction joints, vibrators, and artificial cooling for rapid dissipation of setting heat. Earth dams have developed new technique in handling methods and soil studies. Flexible core walls, improvement in spillways and outlets have aided in making earth dams more secure. All dams have benefited from great improvements in the practice of grouting foundations. The article ends with several tables giving summarized data on dams of all types over 100 feet high, and progress in number of dams of different types from 1850 to date.

#### HOW SHALL THE HEIGHT OF DAMS BE MEASURED ?

The question of what measurement to use in rating the height of any type of dam has become more and more involved as new types have appeared. It is recommended that there should be a standing committee to decide questions of proper rating of dam heights.

#### THE TENNESSEE VALLEY EXPERIMENT—II.

Continued from previous issue. Describes the further operations of the Tennessee Valley Authority. The study of fundamental data including variations of river flow, size of maximum flood, channel conditions, and physical features of reservoir sites. There is a record of several disastrous floods in the Tennessee river basin. "The sum total of the reservoir analyses in the valley was the conclusion that storage while it will reduce flood peaks and frequency of flood hazard, cannot remove the chance of damaging floods at all points".

*No. 25.—December 17, 1936.*

#### ASPHALT IS KING ON WYOMING ROADS.

Five types of road all using asphalt oils compose the main paved system of Wyoming. The features of the country and the roads are described and the five types of surfacing as recently adopted are described in detail.

#### STABILIZING FINE DRY SOIL BY SUB-OILING.

Reid.

Sub-oiling in Oklahoma is being undertaken in a section of the State where the soil is very difficult to maintain as a dirt road, and is too sandy to permit successful gravelling. The process consists of laying a heavy oil mat with existing materials. The oil used is SC-2 material and was placed in the initial application at a depth of 5-6 inches. The details of the process and the machine used are described.

#### NAVIGATION AND POWER ON THE TENNESSEE.

Continuation of an article from the previous issue. Discusses the problems encountered by the T. V. A., in the detailed study of river canalization planning. Tennessee river canalization will



form part of a 7500 mile network of internal water-ways affording minimum depths of 6 feet or more. The only suitable method was found to be construction of dams forming a continuous series of pools. Large locks with chamber size 110 feet by 600 feet are to be provided. Power development has also been provided for, and generating equipment is being installed at some of the dams. A definite cycle of reservoir operation has been laid down. During flood season, the headwater reservoirs will be kept at low levels. Centralized water control is essential for all reservoirs on the Tennessee and its tributaries for their utilization for navigation, flood control, and power.

#### CURRENT NEWS.

A small dam on the Niobara river near Spencer in Nebraska U. S. A. failed because it was founded on a shale so weak as to be hardly more than a mud rock. A number of borings were made in the foundation material and the results indicated a soft black shale. The cores can be broken by the fingers. Mr. Harza states that the foundation material is so very weak that the slightest yielding of the foundation causing the loss of perfect contact between the dam and the shale, could have opened a fine seam between the concrete and the shale and permitted water pressure to enter causing uplift which would have tended to float the structure and weaken its sliding resistance. The dam is an earthen dyke 1,800 feet long, 18 feet high, with a 400 feet concrete spillway section. The latter failed suddenly as a unit.

*No. 26.—December 24, 1936.*

#### CURING ROOMS AND COLD TESTS FOR BETTER CONCRETE.

Glover.

Description of the curing and cold rooms, and the control room of the new laboratory for testing materials of the Illinois Division of Highways. The equipment in the laboratory is described in detail, as also the operation of the different units.

#### THE TENNESSEE VALLEY EXPERIMENT—IV.

Development of the Tennessee River for navigation, water conservation, flood control and power, involves many regional problems including cover cropping and forestation to check erosional silting, and development of recreational and mineral resources. The procedure of the Tennessee Valley Association in dealing with them is outlined in the article. One of the two primary regional problems from the river engineer's standpoint is the promotion of improved agricultural methods to reduce soil erosion and retard the silting of reservoirs. The T. V. A. rebuilt one of the old war-time nitrate plants and proceeded to produce fertilizers. With fertilizers available, farmers were induced to grow more grass and cover crops. Supply of free concentrated fertilizer for which the farmer pays only the freight is the inducement and

there was no attempt at any kind of compulsion. The problem yet to be solved is the prevention of silting caused by erosion of non-agricultural land. Mechanical methods such as construction of small rock check dams have proved too expensive. Terracing of steep land along contours has proved effective in reducing soil wash. Forestation methods are being experimented upon.

#### LETTERS TO THE EDITOR.

##### COTTON SHEETING IN ROADBUILDING.

Deck

Commenting on the article on the above subject published in E. N. R. dated November 26, 1936, says that the following items which are important have been overlooked in the operations described in the article

1. The fabric was evidently used as it came from the mill with the sizing neither softened nor removed from the threads. Consequently the absorptive properties of the fabric have been lowered. Best results are obtained by soaking the sheeting in water for at least 24 hours and applying the preservative while still wet, and then applying the preservative on top before the water leaves the threads. This practice results in better penetration.
2. The fact that any fabric, specially cotton, tends to continue to shrink, and that bituminous coatings are very susceptible to expansion and contraction, has been ignored. Cotton has no elasticity but tends to shrink continuously and the breaking of any thread will gradually spread to a large opening. Fabric should be set to compensate for any differences in movements of materials or it will lose its effectiveness for any purpose.

##### SUTRO WEIR FORMULA.

Pratt.

"Sutro weir investigations furnish discharge coefficients". Mr. Pratt points out an error in the discharge formula for Sutro weir printed in the above article in the issue of E. N. R. dated November 12, 1936. The correct formula should be :

$$Q = ca \frac{1}{2} b \sqrt{2g(h-a/3)}$$

##### CLOUDBURST FLOOD FORMULA.

Guttmann.

The author of the article comments on the criticism of the article by Messrs. Pritchett and Commons in the E. N. R. November 5, 1936. He concludes : " Numerous supplementary data from Tropical India, England and New York recently studied by me have added greatly to the support of my formula and naturally my confidence in its safety has increased in proportion. "

*No. 27—December 31, 1936.*

##### PHOTOGRAMMETRIC SURVEYS GIVE DAM AND QUARRY YARDAGE. Baumann.

Five photogrammetric surveys made with airplane equipment have recently been made in San Gabriel Canyon for Los Angeles county

flood control district. In each case a check survey has been made by the usual ground methods and it is possible to say definitely that results by the two methods agree very closely. The speed and the comparatively low cost of the airplane method of surveys have made it well worth while to employ this method. One limiting element in the aerial work is that it can be done with precision only when using special equipment which involves a considerable investment. Trained operators of great skill and rare optical faculties are necessary for the work. In recent years precise instruments developed for aerial surveys have made it possible to greatly increase their accuracy. An outline of the different purposes served and the nature and cost of these several survey projects are given in the article. A contour map showing the small discrepancies between aerial and ground surveys is also included.

**PREDICTION OF RUNOFF AIDED BY GROUPING RAINFALL DATA.** Eiffert.

"Chapter V of this volume deals with frequency of excessive precipitation making use of isopluvial charts and pluvial indices. There has been more or less hesitation to use these charts and indices. The purpose of this article is to make the data and the methods employed more helpful and to urge engineers to use and test them more extensively."

**THREE HINGE TIMBER ARCH BRIDGE BUILT BY CCC (CIVILIAN CONSERVANCY CORPS) IN OREGON.** Smith.

Describes the details of a highway bridge of creosoted timber arch, 135 ft. span, three hinged, spandrel braced, using treated timber for tension and compression members. The arch ribs are divided into 8 panels, each 16 ft. 10½ in. long. The deck is carried by stringers which rest on floor beams. The floor beams carry the load to the arch trusses at each panel point. The bridge was designed to make fabrication and erection as simple as possible. All members were fully shop detailed and in addition each truss was shop framed and bolt holes bored while assembled in the shop. After fabrication the timber was given an 8 lb. empty cell treatment, using a mixture of 50 per cent. petroleum and 50 per cent. grade 1 creosote. All timber used was selected structural Douglas fir, side cut.

**FRAMED CONCRETE RESIDENCES.** Pioda.

Residences with structural frames of reinforced concrete as distinct from solid concrete walls are being introduced in California. The special features are the use of special steel form in units which can be used in different buildings, and the use of a light weight aggregate which makes concrete 30 to 40 per cent. lighter than that made with natural aggregate. The concrete made with this aggregate has one fourth the thermal conductivity

of standard concrete—a great advantage where concrete roof slabs are used. The aggregate is manufactured locally and is a sort of expanded burnt clay.

#### THE TENNESSEE VALLEY EXPERIMENT—V.

“With a large amount of construction accomplished, the T. V. A. to date has not demonstrated that returns will justify its expenditure. Its experience throws little light on how river development is best carried on.” The T. V. A. project as a whole is essentially a navigation and water conservation undertaking with considerable present and greater future flood control value, and with an important power auxiliary. Considering the large sum spent upto date—\$100,000,000—returns upto now are small—for practical purposes negligible. The outlook for future returns is uncertain. Flood benefits and navigation benefits are indirect returns. Power is the only money return in sight. “The Tennessee Valley experiment then is a precedent and model only in its technical activities. The problems of organizing and financing river development and establishing sound policies to guide its administration as a business and public service undertaking remain to be worked out”.

#### HANDLING OF CONCRETE AND AGGREGATES.

Tuthill.

The separation of coarse and fine aggregate in the various operations of handling the aggregate is one of the principal causes of inferior quality of concrete work. Requirements to avoid this separation, are usually stated in the text of specifications for concrete work but in practice certain factors invariably appear which result in a certain amount of separation. A number of sketches have therefore been prepared showing the correct and incorrect arrangement of equipment detail commonly used.

#### CONSTRUCTION EQUIPMENT AND MATERIALS.

New excavator for low headroom conditions has an overall height of 8 ft. and an extreme width of 8 ft. It will handle muck, clay, gravel, and soft shale and pass  $1\frac{1}{2}$  to  $1\frac{3}{4}$  cu. yd. of material per minute to the bucket elevator. The machine is self propelled on crawlers.

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#### DESIGN FOR MAINTENANCE.

Present day road design makes advance provision for ease of upkeep and future revision and enlargement, closer coordination of design with maintenance will reduce costs and make roads better and safer. Present day practice and defective practices have been outlined by two American Highway Engineers.

## ROAD FOUNDATION PRACTICE.

Foundations were for a long time a neglected element in highway construction. Now they are becoming a subject of somewhat extravagant attention. Current methods of soil stabilization practice have been described in an article by T. E. Stanton, entitled, ' Soil Surveys and Stabilization Control Practice. ' The current practice is to remove unsuitable sub-base material and replace it with suitable material, or blanketing an inferior subgrade with varying thicknesses of selected material. Where suitable selected materials are not available the methods adopted are : treatment with calcium chloride, use of bituminous emulsions and bitumen in some form. Fills are now constructed in 6-8 inch layers properly watered and compacted with heavy three wheel or tamping rollers.

## MEASURES OF SOIL BEHAVIOUR ARE STILL IMPERFECT.

Casagrande.

The writer thinks that full knowledge of the properties of the underlying soils cannot be gained with the ordinary routine tests on disturbed samples. The most important function of future research will consist of taking and testing undisturbed samples from different depths and at such times as to permit study of extreme seasonal variations. Embankments should be so designed as to be safe against failure due to slides. Sliding in the underlying foundations should also be guarded against, and for this, accurate exploration of the substrata is essential. It is in this respect however that most foundation work is badly lacking. No studies have been carried out on the stability of embankments constructed of sandy and gravelly soils. The conclusion is that highway foundation design is in a rudimentary stage and its future is dependent on extensive research which can only be undertaken by highway engineers in cooperation with specialists in soil mechanics.

## SURFACES STILL A PROBLEM.

The design problems of surfacing of the rigid type have not yet been solved. A study of vehicle loads, of temperature and moisture stresses, intricate mathematical analysis and vast experimentation led to the evolution of the modern practice. This evolution has been summarized in an article entitled " Pavement Design has evolved from Practice " by R. D. Brown. In another article entitled " A New Sense of Design Values Needed " J. S. Crandell indicates that design and construction have still a long journey ahead before road surfacing receives respect as satisfactory engineering. He says that the evolution of a perfect joint is the most important problem before the highway engineer. Bitumens need study in relation to the aggregates with which they are used.

**RESEARCH NEEDS COORDINATION.**

In an article entitled ' Research an Integral part of highway design ' Mr. R. R. Litchiser enumerates the extent to which highway research has developed. In another article " Broad gaps are still open in Highway Research " Mr. F. C. Lang reviews the work accomplished by road research and the gaps yet to be filled in.

**WHAT IS KNOWN OF STRESSES.**

Westergaard.

Discusses the part played by theoretical analyses in improvement in road design, and offers a mathematical analysis of corner break in a concrete pavement and stresses near a corner, and the reaction offered by a subgrade.

*No. 2—January 14, 1937.*

**THE DELAWARE AQUEDUCT GETS UNDERWAY.**

The Delaware project for an additional water supply of New York city will be built in two stages. The first stage which will commence directly comprises two reservoirs interconnected with a short tunnel, one on the Neversink river, a tributary of Delaware river, and the other a short distance away on Rondout creek, a tributary of the Hudson River. An aqueduct 85 miles long will convey the water from the second reservoir to the distributing reservoir at the northerly boundary of the city.

**WELDED DESIGN FOR SIX-SPAN CONTINUOUS GIRDER BRIDGE.**

Describes a new highway bridge in Quebec. Girders are continuous over six spans of 107 ft. each and floor beams are made continuous through the girders. It is an all-welded structure. The girders are supported on fixed shoes at the centre pier and on 8 in. diameter segmental rollers at all other points of support. The work in the field comprising pile driving for foundations, pier construction, erection of spans, and welding have been described in detail.

**SKEW ROADWAY ON A RIGHT ANGLE FRAME.**

Hirschthal.

To avoid complications of a skew design over a railroad crossing in New Jersey, it was decided to use a modified rectangular arch with special triangular slab extensions at two corners to support the ends of the roadway.

**SCOUR PREVENTION BELOW BONNEVILLE DAM.**

Stevens.

An exhaustive study has been made by means of hydraulic models to determine a type of baffle that will most effectively prevent scour of the river bed below Bonneville Dam. The spillway portion consists of eighteen bays of 50' each in 12 of which are to be placed steel gates 50 ft. high and in six, three at each end, steel gates 60 ft. high. A 1 : 36 model of three of the gates, spillway,

apron and river bed representing a width of 180 ft. of the prototype was built in the spillway flume which is 5 ft. in width, with glass sides. Some 140 experiments were made on as many combinations of deck, apron baffle, etc., to determine scour. The type of baffle adopted consists of wedge shaped blocks 6 ft. wide, 6 ft. high, with 1 : 1 sloping faces both upstream and downstream. The blocks are in two transverse rows with 6 ft. spaces between the blocks in each row and 30 ft. between the rows. Blocks in one row are opposite spaces in the next row. This type of baffle block has not heretofore been used. It is easily constructed and maintained. Results of some of the tests have been represented graphically.

*No. 3—January 21, 1937.*

**OIL-STABILIZATION OF ROAD BASES UNDER TEST IN MISSOURI.**

Reagel.

Schappler.

“Soil base stabilization with bitumen has taken a pronounced forward step in mechanization in Missouri practice. The machines used and the methods employed are described.....The article indicates the advancing tide of soil base stabilization activity ; emphasizes the increasing volume of evidence of the wide variety of soils capable of stabilization, and it indicates that the equipment engineer is conveniently providing the inventiveness that mechanization of construction processes requires”.

Describes the laboratory work to determine the optimum quantities and types of treating agents, and the sub-oiling by machine.

**PROGRESS AT IMPERIAL DAM.**

This dam is being constructed on the Colorado river in California, 250 miles below Boulder Dam on the same river. The dam will divert 15,000 sec. ft. of river water into the All American Canal. This water before passing on to the All American Canal will be cleared of all heavy silt at a de-silting plant of the mechanical circular scraper type. The All American Canal takes off on the California Bank of the river. At this end the abutment and one pier are founded on rock, the adjoining piers being on concrete piles, 50 ft. long, extending to a gravel layer. The weir section of the dam, 1200 ft. long, will rest on the silt river bed after preparation by rolling. It will have a maximum height of 31 ft. and will be partly filled with sand and gravel ballast for added weight. The structure will be “floated” upon the bed of the river. A long upstream and downstream concrete pavement with sheet piling cut off walls will be used to cut off flow in the stream bed below this portion of the structure. A special feature of the foundation work is the employment of well points, as many as 2800 being in operation. The river silt at the dam site when wet does not stand in embankments ; the angle of

repose may be as low as 10 : 1. With well points in operation moisture is drawn out of the material to such an extent that cohesion becomes effective and almost vertical slopes may be used. The well points are 2 in. pipes with double screened intakes, the length ranging upto 24 ft. 45 well points are operated by a single pump through a 6 inch header. The pumps are of the self priming type and the pumping head ranges upto 20 ft.

#### LETTERS TO THE EDITOR.

**Data required for Flood Prediction :** Comment on a paper by Robert Turner published in E. N. R. November 26, 1936. Full value of flood control works will be obtained only with the maximum foreknowledge of expected floods. Flood prediction on observed rises of stage can serve only on the largest rivers. On small watersheds say upto 5000 or 6000 sq. miles where the flood may reach a peak in two or 3 days after the rainfall, the prediction must be based on the amount of precipitation as it falls, and upon the meteorological and hydrological conditions preceding the storm. Extension of the regular precipitation stations into the head waters and divides of watersheds is necessary.

*No. 4—January 28, 1937.*

#### CONCRETE RIGID FRAME SPAN OF 146-Ft. FEATURES PARK BRIDGE

AT KENOSHA.

Bothe.

A rigid frame span 146 ft. from centre to centre of piers, believed to be the second longest in the United States has been completed in Kenosha, Wisconsin. It is designed for pedestrians to cross a lagoon in a park and is 10 ft. between curbs. The deck slab is 6½ inches thick at the gutters and is crowned 1 inch. It is supported on two ribs 9 ft. 4 in. apart. The ribs are 1 ft. 4 in wide, 3 ft. 1 in. deep at the crown, and 7 ft. 3 in. at the springing. Details of reinforcements, etc., have been given.

#### CONSTRUCTION COSTS OF COTTON-REINFORCED ASPHALT.

Corder.

The use of cotton fabric in bituminous road construction gives a type of reinforcement which will reduce the amount of raveling and the formation of chuck holes in the driving surface. It cements the surface with a seal which prevents infiltration of water and thus reduces winter damage. Experiments as carried out by highway departments in America and experiments in England with jute bear out the above. Consecutive operations in building a cotton reinforced bituminous mat road in Missouri have been described with illustrations. The operations include brooming off old road with rotary power broom, spraying broomed surface with tar, spraying asphalt coat, unrolling the cotton cloth on the asphalt coat, spraying the cloth with hot asphalt, sprinkling pea gravel on the treated cloth, and rolling the gravel into the coated cloth. The costs of construction have been given.



**FLOOD DRAMA.**

Editor's comments on the recent floods in the Ohio and Mississippi rivers.

The flood protection system on the Mississippi built since 1928 consists of a much higher and stronger levee system from Cairo which is at the junction of Ohio and Mississippi, down to the gulf. There are bye-passes at 4 points where the leveed channel is incapable of carrying all the water. Three of the bye-passes are practically completed while the fourth is not yet started and this may lead to a tragedy. The worst danger point is Cairo whose streets are 20 ft. below high flood level. The city is ringed by an earthen wall. A series of cut-offs to eliminate a dozen snake-like bends in the river have been built during the past 4 years. They are a proved success in low water. It remains to be seen whether they are as efficient in a high flood.

**CURRENT NEWS.****FLOODS BREAK ALL RECORDS IN LOWER OHIO VALLEY.**

In the lower reaches of Ohio flood levels reached a height of 10 ft. above the previous records.

**GREAT MIAMI VALLEY FLOODS SHARPLY CUT BY DAMS SYSTEM.**

The only comprehensive flood control system in the Ohio Valley, the Miami Conservancy system, met a severe test at peak flow of the Great Miami River system. It functioned with entire success. The combination of reservoir discharges exceeded that ever before experienced. The peak discharge at Dayton, Ohio was 53,000 c. ft. per sec. Without control by the retarding dams, the discharge, it is estimated, would have reached 90,000 cu. ft. per sec.

*No. 5—February 4, 1937.*

**FLOOD NEWS.**

The effects of the disastrous floods in the Ohio in January 1937 are described. All cities below Cincinnati were submerged and the flood waters rose from 6 to 15 ft. above the highest previous record in this reach. Cairo which is at the junction of the Ohio and Mississippi escaped damage. The flood walls of Cairo were raised by 3 ft. with mud box bulkheads backed with sand bags, during the flood week. A 'fuseplug' levee section below Cairo on the Mississippi had to be breached with dynamite to allow the water into a floodway. The virtually completed Mississippi flood control project faces its first test for the extreme designed capacity as the flood appears to be equal to the "superflood" assumed in the design. This is in spite of the fact that the Mississippi and Upper Missouri Rivers are low.

**CIVIL ENGINEERING IN 1936.--****An Editorial Survey.**

The progress achieved during 1936 in the fields of transportation, highways, water and power, city engineering, structural developments and machinery is reviewed. Under highways the major development is the forward work of soil mechanics laboratories and the advance of practical soil study and stabilization. Amongst water power developments, the most notable is the Boulder Dam project. Power generation was begun at Boulder Dam and at Norris Dam. In the new flood control legislation Congress has authorized the construction of 270 flood control works. Structural developments include new alloy steels, growing acceptance of the continuous truss bridge, glass blocks for walls of buildings, light weight floors of steel, welded construction, and new construction methods in bridge foundations. Two important dam strengthening operations on the lake Pleasant and the Hodges Dam were carried out. There has been a great improvement in the technique of construction operations. The examples quoted are the freezing arch at the toe of a huge earthslide at the Grand Coulee Dam, spinning of caissons to rock for the New York Federal Building, well point drainage works at Imperial Dam and the pumping of pulverized sandstone in excavating the Twin Cities sewer tunnels.

**CIVIL ENGINEERING RESEARCH.**

Lyse.

Studies by the Portland Cement Association of high temperature saturated steam curing showed that concrete developed high strength but the bond between steel and concrete was reduced. Information on the effect of vibration on the bonding of fresh to hardened concrete was obtained by the University of Wisconsin. Data on the detrimental effect of heating and cooling concrete were supplied by the University of Kansas.

Models to study seepage flow through earth dams of the Muskingum River flood control project, extensive model experiments for the design of spillway gates and other structural features of the Bonneville Dam, and similar model experiments for the Grand Coulee Dam and Fort Peck Dam show a great growth in the practical use of model study for research and design. Several model studies on hydraulic structures were carried out at the Case School of Applied Science.

**HYDRAULIC PROGRESS.**

Lane.

The past decade has seen a great advance in laboratories for Government and corporate organizations. Model testing for hydraulic projects has become standard practice. Extensive work on tidal models has been done at the U. S. A. Waterways Experiment Station, Vicksburg, at the Massachusetts Institute of Technology and at the University of California. A fundamental study of the relation of turbulence to the carrying of silt in suspension is being made at the California Institute of Technology.

**BRIDGE ENGINEERING.****Hardesty.**

The important bridges which represent contributions to the knowledge of bridge building are the San Francisco Oakland Bay Bridge, and the Triborough Bridge in New York. Continuous Girder, Vierendeel Truss, and Welded Bridges are features of the modern tendency of European bridge building practice.

**SOIL MECHANICS PROGRESS.****Casagrande.**

The new science of soil mechanics saw a large advance, and the progress in practical application of the science is noteworthy. Prof. Karl Terzaghi's publications are the most valuable and stimulating contributions of the year. Earth dam stability, foundation settlement, hydro-static uplift, improvement of soils by physical chemical and electrical means, are the chief subjects concerned in the year's advance.

**STATUS OF MAJOR PROJECTS.**

A brief description of the progress on some important projects in America, comprising water supply, sewage treatment, flood control, waterways, irrigation and power, land reclamation and bridge construction.

**FLOOD CONTROL BEGUN.****Pillsbury.**

Great floods of March 1936 forced the Congress to pass the Flood Control Act of 1936. The Act authorizes the construction of some 270 flood control projects. These projects are based on comprehensive river surveys directed by the Congress and carried out by Army engineers. The present article outlines in brief the scope and status of the flood control work authorized by the Act. Reservoirs for flood control are the main features of the major projects. Levee construction, channel enlargement and related work are also to be carried out on a number of rivers.

**FORECASTING FLOODFLOWS.****Gregg.**

The aeroplane has brought the meteorologist a new means of learning what is happening in the upper atmosphere, thereby enabling him to make a better prediction of coming weather conditions. The question as to whether the new developments in forecasting will help in anticipating flood flows has been answered in the present article. The author believes that where runoff from a large area is concerned, the weather bureau can be of help but much remains to be learnt before the small storm of intense precipitation can be predicted.

*No. 6—February 11, 1937.*

**ARCH DAM OF ICE STOPS SLIDE.****Gordon.**

Describes the method of freezing an arch of water soaked silt across a rock gorge to stop a sliding mass of earth in the foundation excavation of the Grand Coulee Dam. (See page 96 of this Bulletin).

**FLOOD CONTROL BEING TESTED ON THE MISSISSIPPI.****Hill.**

Description of the flood control works on the Mississippi and the history of the works which were started in 1927. The expected results of the works, and the critical points on the river are described.

**FIGHTING HIGH WATERS.****Richardson.**

In this article the associate editor of the Engineering News-Record gives his impressions obtained first hand of the work done to control the superflood in the Mississippi valley. Levee raising and stopping sandboils behind the levees are the chief lines of attack of the problem.

*No. 7—February 18, 1937.*

**ALL-AMERICAN CANAL PROGRESS.**

Describes the progress of work on the All-American canal. Excavation was 85 per cent. complete. Draglines operating large buckets of 16 cubic yards capacity do most of the excavation. Three types of lining have been used where the bank was in partial fill or built of porous material. The lining consists of selected material carefully compacted. Typical canal sections for various conditions of cut and fill are shown. Other structures include railroad and highway crossings, inlets into the canal, syphons to provide for transverse stream flow, and wasteways for spilling water to decrease the flow or unwater the canal. In the sand dunes, four methods of preventing sand drift into the excavated canal were suggested. These are: spraying adjacent slopes with oil; use of vegetation as a surface anchor; spreading a layer of coarse material to prevent winds from blowing the surface; and the use of a wide berm. The method adopted, with a view to study the drifting sand problem, was to use a wide berm. So far this has proved satisfactory.

**CUTOFFS LOWER THE FLOOD CREST.**

For years the Mississippi flood control experts held to the theory that any shortening of the river by cut off channels across the necks of looping bends would induce the river to cut a new loop to regain its original length and slope. Flood control works were only limited to revetments, dikes, and spurs to hold the river in place. Later on, extensive studies were begun with models at the Waterways Experiment Station, Vicksburg to determine the effect of cutting through bends. The model studies convinced the engineer of the desirability of shortening the river by cut-offs. Twelve cuts were made in the river and it is now conceded that these cut-offs reduced the flood height by 6 ft. in the entire lower river below Arkansas city.

*No. 8—February 25, 1937.*

# **DEVELOPING A NEW WATER SUPPLY FOR LOS ANGELES.**

Describes the project for supplementing the water supply of Los Angeles metropolitan area. The project is known as the Mono Basin project. The Mono basin is a snow catchment area surrounding the Mono lake. The run off from this catchment area will add 150 sec. ft. to the present sources. The special features of the project are two earthfill dams, a tunnel 11.3 miles long through a ridge separating the Mono basin from the adjoining catchment, and conduit construction under difficult conditions. The Grant Lake dam is 90 ft. high and 750 ft. long at the crest. It will be of compacted earth fill with slopes providing for the line of percolation to be 8:1. The material in the fill is being rolled and tamped. The Long Valley Dam is 17 miles downstream. It is 167 ft. high and the crest length is 550 ft. The material of the fill and manner of placing the fill is the same as at the Grant Lake dam. Cross sections of the dams at the maximum sections are given. Difficulties encountered in tunnel construction and the methods adopted to overcome them are explained.

# **ROCK PICKER TAKES OVERSIZED STONE FROM FILLS FOR CANAL BANKS.**

Describes equipment which lifts oversize rock from an 8 inch fill layer ready for compaction. It consists of a revolving inclined cage of cylindrical shape through whose sides fines can escape freely as the machine is moved along a recently placed layer of earth. Oversize rock is retained in the cage.

## **THE RECLAMATION ERA.**

**VOL. 26.**

*No. 12—December 1936.*

# **SIGNIFICANCE OF GRAND COULEE DAM.**

**Banks.**

An address delivered at the Washington State College, on the occasion of dedication of a granite shaft from Grand Coulee Dam. The speaker describes the diamond drilling into the foundation of the dam to an aggregate depth of 6 miles, to make sure of the nature of foundations, and also the boring of a number of holes 36" in diameter to a depth of 50' to provide a means of detailed personal inspection of the rock in place. The columbia basin reservoir formed by Grand Coulee Dam is described. The reservoir has a storage capacity of 5,000,000 acre ft., and extends from the dam to the Canadian border, about 150 miles. The dam will be 4,300 ft. long, 550 ft. high, and 500 ft. thick at the base, and will have a spillway 1,650 ft. long. The power installation will have an output of 1,980,000 kilowatts, of which 800,000 k. w. will be for generation of firm power, and the rest for secondary power for

irrigation pumping. The pumping plant will lift water from Columbia river reservoir to a height of 280 ft. into a smaller reservoir formed by a low dam in each end of the upper Grand Coulee. The distribution system will convey water from this reservoir to 1,200,000 acres of semi arid but fertile land. Such a project will provide farm homes for 25,000 to 40,000 families representing 200,000 people, and will support an urban population of equal size.

#### **CABALLO DAM, NEW MEXICO.**

Ballmer.

Describes the progress of construction of the dam which is a rolled fill dam. Many pits have been dug in the area from which earth for the dam is being taken. Samples from these pits have been carefully tested as to their pervious properties. The least pervious earth will be placed on the outer portions, and the more pervious type will form the core. The material will be rolled with a huge roller in 6 inches thick layers. The dam will serve two purposes—storage for irrigation and flood control. The irrigation water will be discharged through an outlet tunnel 13 ft. 6 inches in diameter with facilities to control the water that will pass through it. The lake formed by the dam will have a capacity of 350,000 acre ft. and will be 15 miles long.

#### **GRAND COULEE DAM.**

A few features of the great dam are mentioned. It will contain 11,250,000 cubic yards of concrete about  $3\frac{1}{2}$  times that in the Boulder Dam. This huge mass of concrete would build a monument 100 ft. by 100 ft. to a height of  $5\frac{3}{4}$  miles. It is estimated that a cubic yard of concrete will be placed in the dam every  $5\frac{1}{2}$  seconds. There will be embedded in the dam a system of pipes containing more than 2,000 miles of 1 inch steel tubing, through which cooling water will circulate to remove chemical heat produced due to the setting of cement in the mass concrete. There will be 18 main generating units each 30 per cent. larger than those at Boulder.

#### **PARKER DAM CONSTRUCTION.**

Two tunnels 29 ft. in diameter and 1,730 ft. long have been constructed 155 miles below Boulder on the Colorado River. The river has been diverted through these tunnels, and the Cofferdams to protect excavation for foundation of main dam will be constructed immediately. The tunnels are designed to carry 60,000 cubic ft. per second.

#### **OVER-IRRIGATION.**

Editorial comments on and extracts from an address by G. K. Parker before California Irrigation Districts Association. Over-irrigation damages adjacent areas at lower levels, and will leach the area irrigated to a point where production therefrom will be insufficient to pay the cost of drainage of excess water from the

low lands. All land thus becomes sub-marginal in character relative to production. Over-irrigation will ruin any soil anywhere for profitable production, and drainage will not cure the situation.

VOL. 27.

*No. 1—January 1937.*

#### **BOULDER DAM ELEVATORS.**

Spearman.

Describes the electric elevators at the Boulder Dam. Their main purpose is to carry workmen to and from work in the power plant. The elevators drop a distance of 528 ft. in 1 minute 3 seconds from the top of the dam to a gallery adjoining the main generating rooms of the power plant. There are other elevators for transportation to the various floors of the power house.

#### **IMPERIAL IRRIGATORS GRATEFUL FOR BOULDER DAM.**

During the flood season height of water in Lake Mead behind Boulder Dam rose from 905 to 1,015 ft. As the elevation of the river below the dam is 645, the depth of water in the reservoir was 370 ft. at the Dam, amounting to 9,000,000 acre ft. which is the equivalent of 3 years use in the Imperial Valley. The valley once threatened with flood and drought each year now has a most reliable water supply.

#### **RADIO SERVICE BETWEEN TAYLOR PARK DAM AND GUNNISON.**

To expedite construction of Taylor Park Dam on the Taylor, communication between the Dam works and the project office at Gunnison was essential. The intervening country was mountainous and subject to heavy snows and telephone line was an expensive proposition. Radio communication was decided upon. It has been in service since May 1936 and has worked satisfactorily.

#### **LAKE MEAD DOES NOT ALTER WEATHER.**

Unauthorized statements were circulated last summer that Lake Mead more than 100 miles long, has caused perceptible changes in the climate and weather. An investigation to enquire into the question was started. The Bureau of Reclamation sought information from residents near Boulder Dam, airplane pilots who fly over Lake Mead each day, and meteorologists, and have come to the conclusion that Lake Mead has not changed the climate or the weather of the tract.

#### **FREEZING ARCH ACROSS TOE OF EAST FOREBAY SLIDE, GRAND COULEE DAM.**

Gordon.

The Grand Coulee Dam foundation consists of solid granite. The overburden of this granite formation is of glacial silt. This material

was found to be unstable at a slope steeper than 4 to 1. When the foundations of the Grand Coulee were being excavated, a number of slides of the material covering the rock occurred. Treatment of these slides varied with the circumstances and conditions in each case. In the case of the East forebay slide a unique method, namely, freezing an arch across the toe of the slide, was adopted. It was desired to restrain the sliding material for such time as was required to remove the desired excavation and concrete sufficient height of dam to be out of danger for the slide. An ammonia and brine refrigerating system was selected for freezing. The brine cooled the material to be frozen, the ammonia cooled the brine, and a cooling water system cooled the ammonia. The brine was forced down pipes constituting freezing points in the arch. The points were spaced 20 in. centre to centre. The arch was formed by 8 parallel rows of points *plus* 25 extra points on each abutment haunch. A total of 377 points were installed. The plant for cooling brine, and ammonia is described. The arch and exposed mains were covered with a 2 ft. layer of saw-dust after thorough testing. At the time that operations were begun on installation of freezing points the material in the centre of the arch was moving at 2 ft. per hour. During the operations, the material reached a state of equilibrium. The difficulties experienced with the operations and the manner of overcoming them have been set forth.

## WATER WORKS AND SEWERAGE.

VOL. 83.

*No. 6—June 1936.*

### CONVENTION OF AMERICAN WATER WORKS ASSOCIATION, LOS ANGELES. JUNE 1936.

A report of the 56th annual convention of the American Water Works Association. Amongst the papers presented may be mentioned the following:

#### PROGRESS ON THE COLORADO RIVER AQUEDUCT OF THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA.

Thomas.

A review of the history and progress made on the scheme. The water will be taken at a point 50 miles down the river in Needles, Arizona, and will be lifted at 5 stations, a total of 900 ft. within 120 miles of the 240 mile travel through conduits, pipe line and tunnels. Difficulties encountered are described. The largest pumping stations in the world are to be built with capacity of 1,600 sec. ft. The water will be distributed to 13 municipalities. Pre-cast concrete pipes 12" thick, steel pipes 1" thick and 10 ft.



diameter, pneumatically lined tunnels by the pump-crete process are other features of the scheme.

**FEATURES OF EQUIPMENT AND DESIGN OF PUMPING STATIONS ON THE COLORADO RIVER AQUEDUCT.**

Spillmann.

Describes the outstanding problems met with in the design of pumping equipment and the development of pumps of twice the capacity of any in America namely 90,000 g. p. m. each.

**THE DUAL USAGE OF WATER FOR DOMESTIC AND IRRIGATION PURPOSES.**

Lippincott.

Review of the development of Los Angeles water supply as a combined irrigation and water supply system. Separate meters are used to measure irrigation and domestic water.

**METHODS USED IN ARTIFICIAL STORING OF GROUND WATER BY SPREADING.**

Lane.

Description of methods employed to spread surface water in the rainy season to secure percolation into and storage in the ground water basin from which it is later pumped. Experimental work during the past 3 years had shown that the shallow basin ponding method was the most practical method.

**GROUND WATER DEPLETION BY UNREGULATED PUMPING.**

Brush.

In the western end of Long Island over-pumping of the many wells has been responsible for a serious lowering of the ground water level, and increasing the salinity of the water. The New York Water Power Control Commission have imposed restrictions with regard to new wells and the problem is being studied to evolve some method of correcting the situation.

**JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION.**

VOL. 28.

*No. 6—June, 1936.*

**CONSERVING OUR NATIONAL WATER RESOURCES.**

Shaw.

The natural hydrologic cycle involves (a) evaporation from exposed water and transpiration through vegetation, (b) precipitation as rain or snow, (c) absorption by the surface and infiltration into the underground strata, (d) surface run-off into rivers, lakes, and oceans. Man has seriously disturbed the natural arrangement by such acts as stripping of forests, unnecessary removal of vegetation, improper tilling, illogical drainage, and excessive straightening and channelling of streams. The effects of this interference by man are erosion, floods, lowering of water table, exceedingly low hot weather flow in rivers, and silting of

reservoirs. The National Resources Board and its allied committees were mainly responsible for apprising the public of the seriousness of the situation. The chief accomplishments of the National Resources Board and the allied committees are set forth. The Soil Conservation Service has published a book entitled "Little waters" dealing with soil erosion and its control. The U. S. Geological Survey will soon publish studies entitled "Flood Flows in the United States" and "Rainfall, Run-off and Ground Water Relations". The Water Planning Committee objectives are described.

## SOIL SCIENCE.

VOL. 42.

*No. 2—August 1936.*

### TRANSFORMATION OF NITRATE IN WATER-LOGGED SOILS.

De.

Sarkar.

This paper describes the methods and results of an investigation to study the effect of waterlogging on the change of nitrates in soils. The experiments showed that nitrates are rapidly lost under waterlogged conditions; that in the presence of a rice crop little nitrate is lost in drainage water, but in the absence of a crop, the loss is considerable.

## PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

VOL. 61.

*No. 9—November 1935.*

(This issue was out on loan at the time of preparing the last Bulletin.)

### INFLUENCE OF DIVERSION ON THE MISSISSIPPI AND ATCHAFALAYA RIVERS.

Salisbury.

The effect of an outlet operative at all stages from the Mississippi River into the Atchafalaya River is discussed. The diversion decreases the volume of the Mississippi and increases that of the Atchafalaya river. The result of this diversion is set forth, and present hydraulic theories are discussed in their application to the behaviour of the rivers under the conditions arising out of the diversion. A like volume of water through the various years is observed, and the passage of this like volume of water past the gauge stations as registered by the gauge heights are analysed at points on both rivers. The analysis shows:—

1. That at points not affected by diversion the same volume of water is now passing at the same elevation as in previous years.

2. The Mississippi river has conformed to hydraulic theory and increased its slope as the volume has been diminished by diversion.
3. The Atchafalaya river has conformed to hydraulic theory and flattened its slope as its volume has been increased by diversion.

The author concludes :—

“Treatment of the silt load by a silt bearing stream is its powerful agency of adjustment to changed conditions. The detrimental effects resulting from this power to adjust itself to changed conditions is reflected clearly in the loss in discharge capacity of the Mississippi river due to unrestricted diversion at all stages. By eliminating diversion below bank full stage a major portion of this power of adjustment is overcome as it will disturb to a minor extent the greater portion of the silt load along the bed of the channel.....overbank diversion will not cause the ill effects suffered from diversion at below bank full stages.”

#### STABLE CHANNELS IN ERODIBLE MATERIAL.

Lane.

The paper describes the results of a detailed study of the problem of stable non-silting canal sections undertaken with a view to evolve a suitable design of the All-American Canal. The studies comprise an analysis of stable channel formulas developed by the British engineers in India, from Kennedy to Lacey. Critical velocities and bed width depth relations on several canals in different parts of the world are compared and found to vary over a wide range. None of the existing formulas therefore could be applied to the problem in hand as they were developed empirically from a limited range of conditions and these conditions have not been delineated sufficiently to enable them to be applied elsewhere. It was therefore necessary to go back to the fundamentals and to analyze the factors controlling the shape of a stable channel in erodible material. The factors affecting channel slope and their relations to one another are discussed at length. Conditions required for stable channels with silt load are analysed. The general shapes of stable channels carrying clear water and suspended materials are considered, and bed width depth relations for various conditions are evolved with arguments for their adoption. The relations suggested are shown to agree with the actual data for most of the canals in existence. The shape of stable channels according to Lacey is semi-elliptical with the major axis horizontal. The writer on the basis of his experience of American canals differs from this view, and holds that channels carrying heavy loads of graded silt have horizontal beds and nearly vertical sides. A bibliography on the subject is appended.

**TRUSS DEFLECTIONS : THE PANEL DEFLECTION METHOD.**

Shoemaker.

The purpose of the paper is to describe a new method for computing the deflections of trusses. Use is made of the distortion of individual panels, and the deflections of all panel points are computed. The method effects a large saving in computation. The principal distortions are expressed by formulas which makes the computation easy and accurate.

**LATERAL PILE-LOADING TESTS.**

Feagin.

The paper describes the result of tests conducted at Lock and Dam No. 26, Alton, Illinois, to determine the resistance under lateral loads of timber and concrete piles driven in Mississippi river sand. Tests were carried out on single pile and groups of four, twelve and twenty piles. The field data are presented in tabular form and results are discussed.

VOL. 62.

*No. 10—December 1936.***CONSTRUCTION AND TESTING OF HYDRAULIC MODELS,  
MUSKINGUM WATER-SHED PROJECT.**Barnes.  
Jobes.

Hydraulic model studies were conducted on eleven dams for the Muskingum Water-shed project, Ohio. In each of the eleven studies, a working model with outlet works, spillway and other features was constructed from preliminary drawings of the dam. The objects of the tests were: (a) to observe and record the behaviour of the model; (b) to determine alterations necessary for optimum performance; (c) to revise the model to complete agreement with the final design and to make complete record tests under the full range of flow conditions anticipated.

**ANALYSIS OF STRESSES IN SUBAQUEOUS TUNNEL TUBES.**

Eremin.

Stresses in a concrete tunnel tube with flexible horizontal ties are analyzed in this paper.

**DEFLECTIONS BY GEOMETRY.**

Hall.

The fundamental method of finding deflexions is by geometry. The few simple rules that are necessary in a geometrical analysis are given in this paper and are illustrated by developing methods for calculating influence lines for such structures as arches, and deflexions in trusses.

VOL. 63.

*No. 1—January 1937.***GRAPHICAL DISTRIBUTION OF VERTICAL PRESSURE  
BENEATH FOUNDATIONS.**

Burmister.

“The most important part of the analysis of foundations deals with the settlement of structures due to the consolidation of compressible strata of clay and fine saturated silt located at some depth

beneath the structure. This involves the practical application of the theory of elasticity in the determination of the state of stress in the underground. In the present state of knowledge the Boussinesq equation for the pressure at a point within the soil mass due to a point load concentrated at the surface is the logical basis for this determination. The practical side of the solution of such problems requires a simplification of procedure in order to make the valuable method of analysis more available. A method is suggested which makes use of the ideas of the influence line and of graphical integration."

Foundation problem may be divided into two general classes. The first deals with the near surface phenomena involving the behaviour of the soil in the disturbed zone close to the individual footings. The second class deals with the settlement over a long period of time of a structure underlaid by highly compressible saturated layers. The detailed analysis of the pressure distribution under a large structure becomes exceedingly long and tedious. The method suggested is a practical simplification of the procedure. The method is simply a graphical method of integration, leading to the preparation of a pressure chart from which pressure at any point in the foundation due to a distributed load on the surface on a footing of any shape, may be found. A typical pressure chart has been included for depth of 10 ft. below the surface.

**STRUCTURAL ANALYSIS BASED UPON PRINCIPLES PERTAINING TO UNLOADED MODELS.**

Gottschalk.

"When the stresses in a structure are investigated by the use of unloaded models, known deformations are produced at a section at which the stresses are desired, and the corresponding displacements are measured at the point at which the load is applied in the actual structure. The ratios between the latter and the former deformations give the required stresses for unit loads, and when the original deformation is taken as unity the models form the influence line of stress. To obtain a moment, a known or unit rotation is produced at the section at which the stress is required; a normal displacement is produced to obtain a shear; and an axial displacement is produced to obtain a direct tension or compression. The geometrical analysis of these operations without the actual use of models leads to fundamental simplifications and it is the purpose of this paper to establish the few simple equations necessary for the use of this method of analyzing statically indeterminate structures."

*No. 2—February 1937.*

**RAINFALL INTENSITIES AND FREQUENCIES.**

Schapmayer.  
Grant.

An investigation of the relation of frequency to rainfall intensity by the statistical method forms the basis of this paper. The increase

in available data in recent years has led to a more complete study of rainfall intensities and frequencies by the Board of Local Improvements of Chicago, a department which designs and builds most of the city's sewers. Rainfall intensity is involved in the design of storm sewer.

The hyperbolic type of formula for intensity of rainfall has been found to fit the data more consistently than the exponential type.

#### **FLOW CHARACTERISTICS IN ELBOW DRAFT-TUBES.**

Mockmore.

The paper presents the results of a study to investigate the flow characteristics in an elbow draft-tube with special reference to the bent part of the tube. The procedure consisted of designing and building several experimental pipe bends and model draft tubes and testing them. The bends and draft tubes were made of pyralin, a transparent material. Motion pictures were made for all conditions of flow in the bends and the tubes. The results of the tests are summarized.

#### **ECONOMICS OF HIGHWAY-BRIDGE FLOORINGS OF VARIOUS UNIT WEIGHTS.**

Waddell.

The comparative economics of different types of modern high-way-bridge floors is presented in this paper. The method provides a rapid solution to such questions. The bridges covered in the records are for simple truss and cantilever spans, for wide and narrow roadways, for carbon steel and silicon steel structures. The use of the diagrams and tables are fully explained and three practical examples have been solved.

**DISCUSSIONS** ON THE FOLLOWING PAPERS APPEAR IN ONE OR MORE ISSUES OF THE PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS GIVEN ABOVE:—

SEDIMENTATION IN QUIESCENT AND TURBULENT BASINS.

COMPARISON OF SLUICE-GATE DISCHARGE IN MODEL AND PROTOTYPE.

MODERN CONCEPTION OF THE MECHANICS OF FLUID TURBULENCE.

SIMULTANEOUS EQUATIONS IN MECHANICS SOLVED BY ITERATION.

ADMINISTRATIVE CONTROL OF UNDERGROUND WATER : PHYSICAL AND LEGAL ASPECTS.

SIMPLIFIED METHOD OF DETERMINING TRUE BEARINGS OF A LINE.

SELECTION OF MATERIALS FOR ROLLED-FILL EARTH DAMS.

BACK-WATER AND DROP-DOWN CURVES FOR UNIFORM CHANNELS.

STRESSES AROUND CIRCULAR HOLES IN DAMS AND BUTTRESSES.

PROGRESS REPORT OF THE COMMITTEE ON FLOOD PROTECTION DATA.

FIRST PROGRESS REPORT OF COMMITTEE OF ENGINEERING-ECONOMICS AND FINANCE DIVISION ON PRINCIPLES TO CONTROL GOVERNMENTAL EXPENDITURES FOR PUBLIC WORKS.

**JOURNAL OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL  
RESEARCH, AUSTRALIA.**

**VOL. 7.**

*No. 1—February 1934.*

**A CO-OPERATIVE SOIL SURVEY OF THE DENMARK AREA,  
WESTERN AUSTRALIA.**

As a result of investigations into the cause of a prevalent cattle disease it was found that the disease was due to deficiency in the mineral content of pastures. A soil survey of the area has therefore been undertaken and laboratory examination of soils will be undertaken by the Division of Soils.

*No. 2—May 1934.*

There is nothing of interest to irrigation engineers in this issue.

*No. 3—August 1934.*

**WEED PESTS—THE PROBLEM OF THEIR CONTROL AND  
ERADICATION.**

The problem of control and eradication of weed pests and the method to be adopted are discussed.

*No. 4—November 1934.*

**THE DETERMINATION OF THE LIME REQUIREMENT  
OF SOILS IN ASSOCIATION WITH SOIL SURVEYS.**

**Prescott.  
Stephens.**

The article presents the results of assessment of the lime status of some acid soils encountered during the course of soil surveys by the Division of Soils.

**VOL. 8.**

*No. 1—February 1935.*

*No. 2—May 1935.*

*No. 3—August 1935.*

*No. 4—November 1935.*

Nothing of interest to irrigation engineers in these issues.

**VOL. 9.**

*No. 1—February 1936.*

**A NOTE ON THE EFFECT OF GREEN MANURING ON THE  
WATER-HOLDING CAPACITY OF SOILS.**

**West.  
Howard.**

The note shows that the effect of green manuring on the amount of water retained by the soil after it has been wetted by rain or irrigation water is of little importance from the point of view of increasing the water-holding capacity of the soil.

*No. 2—May 1936.***TESTS ON THE STRENGTH OF BEAMS NOTCHED IN VARIOUS  
WAYS.**

Langlands.

The common method of notching beams is to cut a right angled gap to form the notch. This results in a considerable decrease in the strength of the beams. Recent work in U. S. A. has shown that this decrease can be considerably reduced by rounding off the notch. The present article describes a series of experiments carried out on an Australian timber. Long and short beams with different types of notches were tested to failure. Conclusions arrived at are that notching the ends of beams and joists seriously affects their strength and should be avoided. If it is unavoidable, the bottom portion of the beam at the notch should be cut in a slanting saw cut, and not rectangular.

*No. 3—August 1936.*

Nothing of interest in this issue to irrigation engineers.

*No. 4—November 1936.***THE HEAT OF WETTING AS AN INDEX OF TEXTURE IN IRRIGATED SOILS.**

Tisdall.

In the irrigation and drainage investigations in the Murray Valley a need has been felt for some rapid and fairly accurate estimate of texture, particularly as it affects soil permeability. For drainage studies in Germany, "the heat of wetting", which is the amount of heat in calories per gram which is evolved when soil is mixed with water has been used as an index for estimating texture of soils. The article describes some experiments to determine the heat of wetting of some soils and to determine the value of the "heat of wetting" in estimating texture.

**FREE-WATER INVESTIGATIONS IN THE SOUTH AUSTRALIAN AREAS OF THE MURRAY VALLEY.**

Tisdall.

The article describes the investigation of the problem of unduly high water tables in the South Australian portion of the Murray Valley. The work has followed three main lines.

1. Examination of existing free water conditions.
2. The relation of free water to irrigation.
3. The relation of free water to agricultural drainage.

Results of the investigations are set forth and discussed. It has been found that levels of the free water rise markedly after each irrigation. Reduction in duration of irrigation resulted in improvement of the plants. The sowing of cover crops is suggested as means of controlling free water.



VOL. 10.

*No. 1.—February 1937.***THE PRACTICABILITY OF SPECTROGRAPHIC ESTIMATION  
OF THE MINOR COMPONENTS OF SOILS.**

Oertel.

**JOURNAL OF THE INSTITUTION OF ENGINEERS, AUSTRALIA.**

VOL. 8.

*No. 7—July 1936.*

(This issue having been received late has been included in this Bulletin).

**DISCUSSIONS AND COMMUNICATIONS.****TECHNICAL INVESTIGATIONS BY MEANS OF MODELS.**

Leech.

Mr. Gibson commenting on this paper, which was published in August 1935 issue of the journal writes: "The author's work in presenting illustrative examples in such great variety would make his paper a reference for those who might require to make use of the theory of dimensions in the planning and application of model experiments. In regard to the formulation of observed relations between dimensionless quantities, one of the examples gave a striking illustration of the dangers of the use of an arbitrary form of equation with coefficients determined by experiments over a limited range. . . . . One very important feature of the use of dimensionless quantities was the fact that they could provide a sound basis for the development and reformulation of relations as experimental knowledge increased."

**THE CONSTRUCTION OF THE CANNING DAM, WESTERN  
AUSTRALIA.**

Dumas.

Munt.

Comments on the paper published in January 1936 issue of the journal by Mr. Dare. The saving effected by the use of bulk cement as compared to cement in bags was given in the paper. The bags were of jute and it is not clear why a supply was not obtained in paper bags as the latter are now generally used and cost less than half of the cost of jute bags.

*No. 12—December 1936.***DISTORTION MEASUREMENTS AT INGLEBURN MULTIPLE  
ARCH DAM.**

Thomas.

Until about the beginning of the present century dams were usually designed strong enough to resist the horizontal water load by dead weight alone. Little attention was paid to the stresses occurring within the structure or to the geological features of the site. With the rapid extension of hydro-electric power and water supply, large dams were essential. Some of the earlier structures failed. Attention therefore was turned to the quality of the material and the nature of the foundations. Some investigators set out to determine the uplift pressures under

dams ; others set out to discover what was happening inside a dam, and how and in what direction the stresses were working. In July 1933 a paper was presented before the First International Congress on Large Dams dealing with the measurement in Switzerland of dam distortion, by triangulation. In this case deflections upto .52 in. were detected. As the construction of the Nepean dam in New South Wales was going on, interest in this subject in Australia was awakened and approval given to the experiments on Ingleburn dam. It was decided to measure the deflections of the largest arch and the two largest buttresses of the Ingleburn multiple arch dam, N. S. W.

VOL. 9.

*No. 1—January 1937.*

**CONCRETE CONTROL AS USED AT THE MOUNT BOLD DAM,  
SOUTH AUSTRALIA.**

Johnson.  
Campbell.

The paper describes the methods employed in controlling the concrete mix in the construction of the Mount Bold Dam, South Australia. The paper gives the reasons for instituting a control system and early experiments relating thereto ; a brief description of the aggregates, mixing, placing and ramming ; factors to be controlled and methods used ; and interesting features and experiments in connexion with or resulting from the control. The Mount Bold Dam is a constant radius arch dam with gravity abutments. The experience of the authors at the Mount Bold Dam, with a controlled concrete used in a comparatively dry state and consolidated by surface tamping, has been summarized. According to the authors some type of control is essential for uniform concrete : concrete without slump and consolidated by surface tamping is successful if layers are kept thin. An increase of fine aggregates improves the strength and physical properties of the concrete. A long mixing time is essential and decreases the tendency of the concrete to segregate. The included air in a dry concrete is in the form of large air voids and it is practically impossible to remove them. These voids are not interconnected to any extent. An increase in the water cement ratio improves the look of the concrete but decreases its strength. The more rapidly the concrete is placed, the better is the result.

**THE CONSTRUCTION OF THE MOUNT BOLD RESERVOIR  
DAM ON THE RIVER ONKAPARINGA, SOUTH AUSTRALIA.**

Cartledge.

The paper details the plant installed by the contractor for the construction of the Mount Bold Dam and mentions the method of river control adopted. Particular reference is made to the supply of materials for the concrete, and the mixing and placing of the concrete. The problems associated with the driving of the outlet tunnel, construction of a stilling pool at the bottom of the spillway and the building of cut off walls to prevent seepage round the abutments of the dam are briefly dealt with.

## DISCUSSIONS AND COMMUNICATIONS.

## DRAINAGE OF IRRIGATION AREAS.

Tolley.

Comments on this paper and replies by the Author. The original paper was published in the Journal of the Institution of Engineers, Australia in December 1935.

## SOME GRAPHICAL AIDS TO ENGINEERING CALCULATIONS.

Bowden.

Comments by Mr. Gleghorn on the paper. The paper was published in January 1936 issue of the journal.

## PUBLICATIONS OF VARIOUS GOVTS., INSTITUTIONS, SOCIETIES, ETC.

## England.

*Imperial Bureau of Soil Science.*

TROPICAL SOILS IN RELATION TO TROPICAL CROPS :  
IMPERIAL BUREAU OF SOIL SCIENCE TECHNICAL  
COMMUNICATION No. 34.

This publication presents a brief summary of soil requirements and actual soil conditions in the chief producing countries, of the following crops : sugarcane, rice, cotton, bananas, citrus, coconuts, rubber, tobacco, coffee, cacao, and tea. It is arranged in crop sections. In each section is given a brief description of the nature of the crop concerned followed by the information about soils and other conditions in the various countries where the crop is grown. The collected facts have been gathered from published papers and only general statements have been included. A list of references is appended to each section.

Periodical publications of the Imperial Bureau of Soil Science—List of Publications relating to Soils and Fertilizers, Monthly letters, Summary of Annual Reports, etc. have been given under 'Periodicals'.

## Germany.

*Institut für Wasserbau der Technischen Hochschule,  
Berlin.*

## THE PREVENTION OF SCOUR BELOW WEIRS.

Ludin.

Bulletin No. 2. (In German).

This describes experiments which show that scour is reduced when the pavement is terminated with a wall, thus forming a cistern and is entirely eliminated when a biff wall or baffle is introduced in the cistern between the weir and the wall at the end of the pavement.

## (1) ORIFICES, OVERFLOW WEIRS, DISCHARGES.

Bundschu.

## (2) THE STANDING WAVE.

Bulletin No. 5. (In German).

(1) An analysis of the theory of discharge through orifices and over weirs from consideration of the energy equations.

(2) Calculation of the standing wave below an under-flow gate.

## CONTRIBUTION TO THE STUDY OF STANDING WAVES. Bulletin No. 15. (In German).

Pietrkowski.

A theoretical discussion of the problem based on laboratory experiments.

## THE PROBLEM OF THE SAFETY OF DAMS.

Hertwig.

Bulletin No. 14. (In German).

Ludin.  
Petermann.

Deals principally with the strength of concrete.

CONTRIBUTION TO THE STUDY OF RESISTANCE TO FLOW IN COMPLETELY ROUGH OPEN RECTANGULAR CHANNELS OF HYDRAULIC RADIUS  $\leq 0.05\text{m}$ , IN THE REGION OF TRANSITION BETWEEN LAMINAR AND TURBULENT FLOW. Bulletin No. 16. (In German).

Vuille.

An account of laboratory experiments.

## OBSERVATIONS ON THE BEHAVIOUR OF WATER FILAMENTS IN CAPILLARIES. Bulletin No. 21. (In German).

Oehler Vedi.

An account of laboratory experiments.

India.

*Central Government.*

## ANNUAL REPORT OF THE PUBLIC HEALTH COMMISSIONER WITH THE GOVERNMENT OF INDIA FOR 1934, VOLUME I.

In section I, the Report says " If food production keeps pace with population increase, a critical situation may be avoided, but India needs more than this. A higher standard of living, with all that this brings in the way of improved health and welfare, is a pressing need which can only be obtained, in a predominantly agricultural country, by a considerable increase in food production or a pronounced drop in the annual increment of population. "

Section 2 of the report deals with the history of the chief diseases. In the chapter on malaria reference is made to the Sind Malaria Enquiry which is drawing to a close. Effects produced by the operation

of the Lloyd Barrage Scheme on the incidence of malaria in Sind have been summarized in a paper prepared for publication by the Malaria Survey of India by Covell and Bailey. The writers state that many parts of Sind were highly malarious before the Lloyd Barrage Scheme came into operation. The contention that most of the malaria now existing is due to the Barrage scheme is unsupported by facts. Nevertheless it is a fact that malarial conditions have become considerably worse since the Barrage Scheme began to operate and this is due to the following factors brought about by the operation of the Project.

- (1) Rise in subsoil water level.
- (2) Actual and threatened waterlogging in certain areas.
- (3) Seepage from new canals.
- (4) Cutting off of sections of old canals.
- (5) Formation of a lake above the Barrage.

Attention has been drawn to importance of making a soil and sub-soil survey of the area and providing an efficient scheme of drainage.

In the U. P., the areas along the main Hardoi Branch of the Sarda Canal in Shahjahanpur and Pilibhit Districts were found to have developed hyperendemic conditions and the spleen rate varied from 60% to 100%.

In Delhi, the zone irrigated by the Western Jumna Canal is heavily malaria infected.

The engineering branch of the Malaria Survey of India conducted studies of waterlogging and drainage problems in relation to malaria in Sind and Punjab, of obstructions of drainage caused by roads and of engineering in relation to various aspects of incidence and prevention of malaria.

SCIENTIFIC REPORTS OF THE IMPERIAL INSTITUTE OF  
AGRICULTURAL RESEARCH, PUSA, 1934-35.

Report of the work carried out by the Imperial Institute of Agricultural Research at Pusa, Karnal, Coimbatore and other places. The researches and investigations carried out are described in detail. The investigations comprise soils and fertilizer experiments, crop breeding experiments, study of plant diseases and insect pests, and animal husbandry. Trials of agricultural machinery were also carried out.

*Institution of Engineers, (India).*

DESIGN AND CONSTRUCTION OF MOSQUITO-PROOF  
BUILDINGS IN INDIA. (Advance copy of paper).

Raja Ram.

The paper sets forth the special requirements of malariology in relation to housing and the design and construction of six types of mosquito proof houses. A feature of all the types is the use of

screens of wire mesh for doors, windows, clerestory windows, vestibules, etc. 11 plates giving plans and elevations with dimensions are attached. There is an appendix on malaria, its ætiology, and some methods of prevention.

*Mining and Geological Institute of India.*

TRANSACTIONS OF THE MINING AND GEOLOGICAL  
INSTITUTE OF INDIA, VOL. XXX, PART 2, FEB-  
RUARY 1936.

THE MOVEMENT OF UNDERGROUND WATERS—  
WITH REMARKS ON RADIO-ACTIVE WATERS AND  
MINERAL SPRINGS.

Fox.

This is the summary of a lecture delivered at Dhanbad and illustrated by lantern slides. It is stated that the rate of flow of water through rocks depends on the size of pore spaces, not on the percentage pore space volume. Clays with 50 p. c. pore space volume may be impervious while sand with 25 p. c. pore space volume may be highly pervious. Percolation of water through pore spaces of relatively porous rocks may continue a great distance under a comparatively low pressure. Friction or resistance to flow must be small in such rocks. In practice it is found that when water is withdrawn from a well in a porous stratum above a definite rate, the inflow of water is insufficient to maintain the level in the well. The rate of flow has a maximum value for a given pore space size, and the quantity obtained will depend on the surface of the rock exposed. It follows that an open well is superior in capacity to a boring, though the latter may be cheaper, below depths of 100 ft. Boring is more economical for an underground supply from very porous strata where water is under pressure. In hard rocks a tube well is very unlikely to tap underground water. When the removal of underground water brings away material in solution subsidence may occur.

Marked variations in the porosity of rocks may be found as a result of faulting. A dyke of igneous rock may cut porous strata and function as a dam and hold up water. The occurrence of several springs or water seepages on a straight line draws attention to the existence of such a dyke of impervious rock.

Earthquakes invariably affect the movement of underground water—by causing water bearing sands to oscillate. They produce a discharge of much of the contained water from vents seen in alluvial tracts after an earthquake.

*Indian Academy of Sciences.***UPLIFT PRESSURES UNDER WEIRS WITH THREE SHEET PILES.**Luthra.  
Vaidhianathan.

(Reprint from Proceedings of the Indian Academy of Sciences, Vol. IV, No. 4, October 1936).

In a series of papers published in the Memoirs of the Punjab Irrigation Research Institute and in the Proceedings of the Indian Academy of Sciences the results of extensive investigations on uplift pressures under simple floors, and under weirs with one and two sheet piles have been published. The investigation has been extended to weirs with three sheet piles and the results of the experiments are set forth in the present paper. The technique of the method is the same as in previous investigations. Uplift pressures under weirs with three sheet piles have been determined for different positions of the intermediate pile, and by studying the effect of varying the length and position of the intermediate pile, working rules have been obtained for the design of weirs with 3 sheet piles.

*United Provinces.***IRRIGATION ADMINISTRATION REPORT OF THE UNITED PROVINCES FOR THE YEAR ENDING MARCH 31, 1936.**

Section VI deals with Irrigation Research. Two important cases were investigated by model experiments. These are the Sarda Barrage at Banbasa, and the Deoha Barrage at Duni. In the first case a dentated sill device was evolved to counteract scouring action below the downstream floor. In the second case, the model experiments allayed the fear that the scour downstream would develop to a dangerous degree during floods. Other works included channel losses observations, experiments with various types of canal lining, silt investigations and analysis of silt samples and observations of the actions of various types of silt selective heads. A flume for model experiments was constructed at Banbasa.

Section VII deals with hydroelectric progress. The revised estimate for the Ganges canal hydroelectric project amounting to Rs. 342.88 lakhs was sanctioned by the Secretary of State and provides for the construction of seven canal power houses yielding 18,900 K. W., a steam generating station with a capacity of 9,000 K. W., and 1,500 State tube wells.

Section VIII deals with development activities and details the progress of State tube well construction and electrification schemes of some channels in which supply of canal water has been stopped or reduced, and replaced by tube well supply. A small scheme which provides for pumping 160 cusecs from the Gogra river

and the erection of a power house to work the pumps and supply electricity to Fyzabad has recently been sanctioned by the Government as an experimental measure.

#### THE UNITED PROVINCES STATE TUBE-WELLS ACT, 1936.

This is a new act passed by the Legislative Council of the United Provinces to provide for the construction, improvement and maintenance of State tube well irrigation works. It restricts the concentration of tube wells, with the object of conserving the underground water supplies.

#### GUL LOSSES EXPERIMENT BY COMPARTMENT METHOD.

This is a form for recording observations of experiments on losses in guls or water courses as used in the United Provinces. Instructions for carrying out the experiments are printed on the back.

#### LECTURE DELIVERED BY SIR WILLIAM STAMPE ON DECEMBER 6, 1936 ON "SOME ECONOMIC ASPECTS OF ELECTRICAL DEVELOPMENT IN THE UNITED PROVINCES."

The lecture was delivered under the auspices of the United Provinces Branch of the Institution of Engineers, India. The progress achieved on the Ganges Hydro-electric Scheme has been described, and the technical and economic problems involved in the development of electrification in the Eastern parts have been discussed. The possible means of electrification are (1) private enterprise, (2) state generation of bulk power and distribution by private agencies under licence, (3) state generation and distribution. The respective merits and demerits of the above means have been discussed. The most economical source of power and the relative values of local steam generation and more distant hydro generation have been considered.

#### ADDRESS TO THE MINISTERIAL ASSOCIATION OF THE IRRIGATION DEPARTMENT, UNITED PROVINCES, BY SIR WILLIAM STAMPE, CHIEF ENGINEER, ON DE- CEMBER 31, 1936.

Reference has been made in the address to the hydro-electric development in the United Provinces which has contributed substantially to the relief of unemployment of the educated besides offering numerous amenities for urban and industrial life.



GOVERNMENT OF THE UNITED PROVINCES, P. W. D.,  
IRRIGATION BRANCH, COMMUNIQUE DATED JANU-  
ARY 1, 1937, ON "ELECTRICAL DEVELOPMENT IN  
THE EASTERN DISTRICTS OF THE UNITED PRO-  
VINCES."

The Communiqué defines the policy of the U. P. Govt. in dealing with pending and future applications for electric licences. The Western Districts of U. P. have a supply of electricity for the smaller towns and rural centres provided by the Ganges Hydro-electric Grid which is now rapidly extending over Western Rohilkhand and Agra Divisions. The principal fields now available for future individual enterprise are the rural areas and smaller towns of the central and eastern Districts of the Province. The Govt. have satisfied themselves that provided certain irrigation pumping loads now under examination are available at stations located on the eastern rivers it is possible by connecting these pumping stations with a high tension network to furnish power at intermediate towns at a rate which will facilitate the development of minor industries. Statistics based on the operation of the hydro-electric grid in the West indicate that the bulk rates at which electricity could be delivered at the towns in the Eastern districts would be lower than the cost of generation in smaller quantities. On a review of the above considerations, Govt. have formulated the principles which will govern the grant of electrical licences in future. These principles have been stated in the concluding portion of the Communiqué.

*Central Provinces.*

REPORT ON THE WORKING OF THE DEPARTMENT OF  
AGRICULTURE IN THE CENTRAL PROVINCES FOR THE  
YEAR ENDING THE 31ST MARCH 1936.

Part III of the report deals with research and experimental work. In the Cotton Botanist's section researches for evolving selected strains were continued and one strain is said to have achieved remarkable success under varying conditions of soil and climate. The rice research scheme comprises a survey of the main rice soils of the Province and determination of mechanical and chemical composition of soils at different depths. It has been shown that a high percentage of phosphoric acid in the soil does not lead to high yield of rice. High yields of fine paddy can only be obtained from neutral or slightly acidic soils. The soil acidity decreases with depth. Most of the soils examined showed lack of soil humus. Hybridization to secure heavy yielding types is being carried out. The section responsible for research on wheat, oil-seeds, pulses and fodder is carrying out research on rust resistance of wheat, and on evolving selected strains of gram and pulses, etc. In the Chemical Section

the effect of different types of waste products from shellac factories on plant growth was investigated. An investigation into the best method of making "gur" has been undertaken.

### *Punjab.*

#### PUNJAB IRRIGATION RESEARCH INSTITUTE REPORT FOR THE YEAR ENDING APRIL 1936.

In this report a brief account is given of the research work that has been carried out by the various sections of the institute. The principal researches carried out in the several sections are as follows :—

##### Chemical section :—

- Movement of moisture and salt in soils ;
- Kankar formation in soils ;
- Prevention of seepage from canal by producing a clay puddle *in situ* by chemical means ;
- Reclamation of alkali soils by electrodialysis.

##### Physics section :—

- Uplift pressure on weirs with different floor and pile arrangements ;
- Examination of models of existing weirs ;
- Silt investigations ;
- Stability of soils and foundations.

##### Mathematical section :—

- Investigations and mathematical treatment of problems of sub-soil flow ;
- Problems of silt movement and design of channels.

##### Statistical section :—

- Studies in the effect of surface sources of water on the behaviour of the water table in various doabs.

##### Hydraulic section :—

- Investigation of uplift pressures on models of standard forms and works ;
- Investigation of models of works in the flume.
- The investigations included complete examination of a number of weirs in connection with the reduction of action downstream.

##### Land Reclamation section :—

- Experiments in connexion with cropping and manuring of reclaimed soil ;
- Study of the effect of gypsum in preventing soil deterioration under irrigation.

In addition to the work carried out for the Punjab Government a considerable amount of advisory work has been undertaken for the Governments of other Provinces.

**PROCEEDINGS OF THE PUNJAB ENGINEERING CONGRESS,  
1936, VOL. XXIV.**

The President Mr. Macfarlane in his address gave a résumé of the principal achievements carried out by the various engineering departments of the province during the previous year. In the irrigation Branch the most important work was the reconstruction of the Khanki weir. Other works mentioned are: Construction of silt excluders and silt ejectors at the head of the Upper Jhelum Canal, the Deg fall, and silt ejector on the Salam-pur feeder of the Upper Bari Doab Canal. Schemes in progress under the five year drainage plan are also mentioned.

The President's address was followed by a speech by the Hon'ble Minister of Education. He congratulated the various Departments of engineering on their achievement and stressed the necessity of developing the mineral resources of the country, and production of power at a much cheaper rate than is now prevalent. The following papers were read and discussed.

**SCIENTIFIC IRRIGATION CHANNEL DESIGN.**

Blench.

The principles of design of channels which have formed themselves in their own silt have been determined empirically and given by Lacey in the Institution of Civil Engineers' papers Nos. 4736 and 4893. This article presents them in a manner suitable for the canal engineer and explains their meaning and correct application. The formulæ which are four in number are given and their significance and use are explained. Defects of conventional remodelling are discussed. The procedure to be followed in a large scale remodelling is detailed and some concrete instances of faulty remodelling are given. Design of off-takes in order to secure an equal distribution of 'f', the silt factor, in branch and parent channels has been dealt with, and rules for design are formulated. Finally, he analyses a table of data of channels in steady condition prepared by the Executive Engineer, Kirana Division and shows how without a complete knowledge of the Lacey theory, a very painstaking collection of data can lead to wrong deduction. The table of data referred to above was intended to be a criticism of the Lacey theory.

The paper is followed by a report of the discussion.

**WATER DISTRIBUTION AND ASSESSMENT OF REVENUE  
AT VOLUMETRIC RATES.**

Khushi Ram.

The author is of the opinion that the volumetric system of assessing water rates is in every way preferable to the system in force at

present. The volumetric system however has its drawbacks. The author in this paper proceeds to show that the difficulties in putting the system to practice can be overcome, and the system may be made to work successfully. He enunciates the general principles of water distribution and assessment and examines the present system of assessment in the light of these principles. Principal defects of the present system are pointed out and the method is characterized as "anti-deluvian". He then proceeds to describe in detail the volumetric system which he believes to be free from the defects of the present system. The main feature of the system is the provision of a masonry flume with a gauge in the watercourse of each outlet. The gauge of the flume gives an index of the discharge passing and the gauge will be read daily by a team of gauge readers, each of them responsible for a certain number of outlets. The 'patwari' or irrigation recorder would maintain a continuous record of water delivered to cultivators by noting down 'waris' or periods during which water was taken by shareholders on an outlet. The 'patwaris' work is described in detail. The system of remission under the proposed method is also explained at length. In conclusion, the chief advantages of the system are set forth. In an appendix to the paper, the design of a masonry flume for a watercourse is described in full with drawings.

In the course of the discussion on the paper most of the speakers showed themselves sceptical of the efficacy of the proposed system.

#### A SILT SELECTIVE DISTRIBUTARY HEAD REGULATOR.

Sharma.

This paper describes two sets of experiments which were carried out on distributary head regulators to investigate the efficiency of several current silt excluding devices and to evolve a suitable design for such a device. The first set of experiments was conducted on existing distributary head regulators on the Jhelum Canal of the following type :—

Wood's rising cill gates.

Gibb regulator.

Flume head regulator.

Regulator with skimming platform.

Silt selective head regulator.

Head regulator with a cantilever skimming platform.

The second set of experiments was carried out on a model of a silt selective head regulator. This model was modified to suit eight different designs for the eight experiments of the set. Each of the experiments of the first and second set are briefly described, and the procedure adopted in each case is outlined. Results

of the experiments are discussed. The method of design of a suitable silt selective head is then outlined, and monograms to help in the design are given at the end. The author's conclusions are that Gibb's regulator, Wood's rising cill gates, Routh's regulator with skimming platform, and King's silt vanes provide distinct improvements towards solving the question of silt exclusion at distributary head regulators, but none of these is ideal. The silt selective head described in the paper is an efficient silt excluder and a successful head. Successful distributary head regulators of the type described in the paper were constructed at 4 sites on the Jhelum Canal.

A discussion on the paper follows.

**ELECTRICAL METHODS FOR DETERMINING PRESSURE  
DISTRIBUTION UNDER HYDRAULIC WORKS.**

Vaidhianathan.  
Gurdas Ram.

In a series of investigations carried out in the Irrigation Research Institute, Lahore, it was definitely established that the distribution of uplift pressure under hydraulic works follows the same law as the distribution of potentials in conductors. The method was extended to the study of uplift pressure under weirs. A number of standard cases such as a flush floor with sheet pile, depressed floor with sheet pile, floors with two sheet piles, etc., have been investigated by this method. The present paper gives the results of investigations on different designs of Trimmu weir of the Haveli Project, Meralala weir, Kalabagh weir, and an inlet in the Lower Chenab Canal. It also gives the results of investigations on single sheet piles without upstream or downstream apron.

Diagrams of pressure contours and hydraulic gradients are given for the weir investigations. The law of variation of pressure at the end of a sheet pile and its efficiency in cutting off pressure under different conditions are diagrammatically represented, and tabulated.

**RECONDITIONING OF KANKAR ROADS.**

Brij Mohan Lal.

The paper describes some methods of reconditioning kankar roads with stone ballast and tar, or in the case of roads carrying bullock cart traffic with water bound macadam. An analysis of comparative costs of reconditioning kankar road with stone metal, maintaining it with bitumen for 20 years, and making a cement concrete road over the kankar is given in an appendix.

**SILT MOVEMENT AND DESIGN OF CHANNELS.**

Bose.

The problem of determining the regime of flow of water in artificial channels is a difficult one. Of the recent attempts at empirical solutions of the problem, those of Kennedy and Lacey are worth mentioning. Mr. Lacey in two papers contributed to the Institution of Civil Engineers, London, has evolved a number of

equations to be used in channel design. In these, he has introduced a quantity known as the silt factor 'f'. The author however does not think that the silt factor is a silt characteristic directly connected with the silt a channel is carrying. In the present article, the author has attempted to evolve a method of design of channels based on relationships in which he has introduced a new factor, the Schocklitsch number, which he maintains is a real characteristic of silt. Part I of the paper is devoted to analysis of bed silt samples by siltometer and the plotting of silt size distribution curves. Distinctive types of distribution curves and their significance are discussed. These curves are an index of the state of equilibrium of a channel. Part II deals with design of channels. It is shown how the Schocklitsch number is worked out from silt size distribution curves. Three equations are given with which it is possible to design a canal system or remodel a distributary knowing only the discharge and the silt that the system will carry. The third equation is Mr. Lacey's in which the silt factor is not involved. The first two equations have been derived from a collection of regime data given in table IV attached to the paper and are empirical relations.

**CONCRETE TRACKWAY ON LAHORE MULTAN ROAD MILE  
2 AND 3 IN LAHORE DISTRICT.**

**Bhikam Singh.**

This paper describes the construction of a concrete track 7 feet wide on the side of the existing road, which is 16 feet wide and has a tarred surface. The concrete track was provided for heavy bullock cart traffic.

**FLOODING OF ROHTAK CIVIL STATION IN SEPTEMBER  
1933 AND MEASURES TAKEN FOR RELIEF AND FOR  
FUTURE SAFETY.**

**Kanwar Sain.**

The civil station of Rohtak is situated in a saucer shaped depression. On 18th and 19th September 1933 there was recorded a rainfall of 26.24 inches in 32 hours. As a result of this heavy rainfall, the civil station was flooded. The depth of water ranged from 5 feet to 10 feet at places. This paper describes the methods adopted for immediate relief and the scheme for permanent relief which was sanctioned and constructed later.

The chief sources of inundation are mentioned and an attempt has been made to estimate the volume of water from these sources. Amongst the measures adopted for immediate relief is mentioned the installation of six oil engine pumps with a total capacity of 4.05 cusecs. The effect of the pumps was confined to small local areas and they proved expensive. Other methods adopted were the breaking through of the steinings of 18 wells to increase the passage of the accumulated water, and fissuring the soil by explosives to increase the rate of percolation into the soil. The latter

method proved futile, and the former of little benefit. The only effective means of disposal of the great volume of water was natural absorption.

For future protection, detailed investigations were carried out by the officers of the Irrigation Branch. Various proposals were made but were rejected mostly on grounds of cost. The scheme finally sanctioned is designed to prevent the run off from the neighbouring catchments running into the Rohtak depression. It consists of a bund to cut off the inflow with a drain alongside it to divert the water. These works are described in some detail with diagrams.

The discussion on the paper is given.

#### RECONSTRUCTION OF THE KHANKI WEIR.

Khosla.

This paper contains a detailed description of the reconstruction of the Khanki weir at a cost of 38 lakhs of rupees. The work comprised the reconstruction of 3,000 ft. of the old weir, the construction of 900 ft. of depressed and gated undersluices, three divide walls, a fish ladder, 2,000 ft. of guide banks, 1,400 feet of silt ejector tunnels, and dismantling of 4,000 ft. of the old weir. The programme of construction was complicated owing to the necessity of maintaining an unimpaired supply of water in the canal while the work was in progress. In the design and execution of this work are embodied the latest methods in headworks construction. A short history of the old work which was built in 1891 is given. The weir is founded on the sandy bed of the river and the work was damaged soon after construction. Repairs were carried out as a result of Colonel Clibborn's experiments at Roorkee but further leaks were observed downstream of the masonry floor soon after the repairs. Serious damage occurred to the work in 1932, and the whole work was suspected to have been undermined by piping. A comprehensive scheme of reconstruction was sanctioned in 1933. The principal features of the reconstruction scheme are described. In six out of eight bays in the old weir, the entire impervious floor has been reconstructed and protected with a continuous line of interlocked sheet steel piling upstream and downstream. The floor below the downstream pipe line has been reconstructed as an inverted filter. Bays 4 and 8 of the weir have been entirely reconstructed, and a set of six silt excluding tunnels have been constructed in front of the main canal regulator. The silt trouble in this canal dates back to 1907 and the various means adopted to cope with it are mentioned. The measures of silt exclusion which formed part of the reconstruction scheme have so far been found to work well. For dissipation of energy downstream a system of arrows on the impervious floors was adopted. The concrete in bays 4 and 8 was laid in layers and not *en masse*. The advantages and disadvantages of laying

concrete *en masse* and in layers, are discussed. A noticeable feature in the works was the liberal use of precast units. Pile driving has been described at length. An analysis of rates for various items of work is included in an appendix.

Model tests were carried out to determine the length of protection required below the right bank undersluices and to test the efficiency of the arrows and blocks used for dissipating energy. Pressure pipes have been erected on a liberal scale on the whole work.

The discussion centred round laying of cement in layers and *en masse*, the water cement ratio, and silt exclusion.

#### PIPE LINE, PENSTOCK, PIPE TUNNELS AND SURGE SHAFT

ON THE MANDI HYDRO-ELECTRIC SCHEME, PUNJAB.

Boddington.

The object of the Mandi Hydro-electric scheme is to obtain power from a fall of 300 cusecs through 1,768 ft., on the Uhl and Lambadag rivers, tributaries of the Beas. Small weirs have been placed across the two streams and the water diverted into a flume which feeds a tunnel 3 miles long passing underneath a ridge. Thence the water flows through two pipes into the penstock pipe line proper, which runs down the mountain side to the power house at a slope of 1 in 3, dropping through 1,484 ft. along the slope. There are 4 pelton wheels and generators in the power house, of which three will be in use at a time, the fourth being a standby. The article describes the penstock pipe track, pipe tunnels, and the surge shaft or the safety valve of the tunnel. The description is given under the following heads.—

1. Driving the pipe tunnels.
2. Sinking the surge shaft.
3. Lining the pipe tunnel with pipes and concrete.
4. Lining the surge shaft.
5. Construction of concrete anchors and supports for the penstock.
6. Erection of penstock.

PUNJAB ENGINEERING CONGRESS, 1937.

(Advance copies of papers).

#### WATERLOGGING ON THE UPPER CHENAB CANAL—ITS CAUSES AND CURE. Paper No. 197.

B. N. Singh.

This paper discusses the rise of water table in the Upper Chenab Canal area soon after the canal was run with high supplies in 1916. The evil went on increasing and became very serious in 1925. To combat this evil several measures were adopted in 1923, some of which were the construction of seepage drains, lowering full supply levels of the main canal, tube well pumping, restricted supply for irrigation, pumping in local areas, and surface drains. These measures are described in detail and their effects



on the lowering of water table are discussed. The lowering of F. S. L's in the main canal is considered by the author to have produced no benefit. The author then discusses the causes of waterlogging at length and comes to the conclusion that waterlogging is caused to a large extent by seepage from the canal system and to a small extent by increased absorption of rainfall from breaking up of new areas for cultivation. In the author's opinion the most effective measure to lower the water table is the provision of a suitably designed system of drains in the area affected. Natural drainage lines should be opened up. The author favours the construction of wide shallow surface drains at a minimum distance of 1,000 ft. from the canal which will carry away the rainfall quickly. Deep seepage drains are only justified in areas where the water table is so near the ground surface that cultivation is impossible.

**AGRICULTURAL ECONOMICS WITH SPECIAL REFERENCE  
TO IRRIGATION PROBLEMS IN THE PUNJAB. Paper  
No. 198.**

Roberts.

In this paper the author indicates some lines along which economies in the distribution of water are possible, and also discusses future possibilities as regards increase of kharif supplies. The points affecting the economy of irrigation water as mentioned are : the number of kiaris per acre, proper consolidated arrangement of plots instead of scattered plots, economy through better implements, and the use of available water on the best land instead of spreading the irrigation on the largest possible area of ground. These points are discussed in detail. The author believes that the main hope of future expansion of irrigation lies in the increase of kharif supplies. The food value of bajra, jowar and other millets is only slightly inferior, if at all, to that of wheat and as these are hot season crops increased cultivation of these crops is essential for future development of irrigation. The paucity of leguminous crops in the Punjab is also a grave defect of Punjab agriculture.

**THE RAISING OF JHELM BRIDGE.  
Paper No. 199.**

McIntyre.

This paper describes briefly the raising by 4 ft. of all the spans of the railway and road girder bridges over the river Jhelum at Jhelum.

**THE ROADS TO KULU.**

Paper No. 200.

Johnston.

This paper presents a review of the important roads in Kulu, historic and otherwise, and discusses costs of construction and maintenance of bridges and roads, vehicle operation costs, effect of road surface on operation costs, effect of gradients on operation costs, effect of curvature on operation costs, etc.

**TURBULENT FLOW IN CHANNELS.**

Paper No. 201.

Blench.

In this paper the author puts forward a new energy theory and an energy equation evolved from general considerations and simple hydraulic concepts. From this energy equation, the Lacey regime test formula and flow formula can be derived, and also the formula defining 'f' the silt factor. By extending the new energy relation to rigid channels the author has derived another exponential formula  $V = \text{Const. } R^{\frac{5}{8}} S^{\frac{3}{8}}$  which is the dynamically sound form of Mannings formula. To test the new formula, the author referred to Barne's "Hydraulic Flow Reviewed" and plotted available data for 3 different rigid sections. In each case the formula fits the data accurately thus justifying the correctness of the new energy theory of the author.

**A NOTE ON THE BUILDING OF TWO REINFORCED CONCRETE BOX CULVERTS ON THE NORTH-WESTERN RAILWAY.** Paper No. 202.

Kumar.

**SOME NOTES ON GUNITE AND ITS USES ON CERTAIN WORKS ON THE NORTH-WESTERN RAILWAY.** Paper No. 203.

Kumar.

This paper describes the process of guniting and the equipment used for that work. Precautions necessary while guniting are set forth. The advantages of guniting over plastering with a trowel are enumerated. A few works on the N.-W. Railway where guniting was done are then described.

**THE DEG DIVERSION AND THE COMBINED HEAD FALL AND AQUEDUCT.** Paper No. 204.

Kapur.

This paper describes the work of the construction of Deg fall and aqueduct on the Upper Chenab Canal. The Upper Chenab Canal runs through low lying country and this has resulted in waterlogging of lands adjoining the Canal. The Deg diversion scheme which provided for the diversion of the main canal at its 57th mile into the Deg Diversion Channel leading to the Ravi River is expected to eliminate considerably the waterlogging evil in the area below this point on the main canal. The work consists of an 8 ft. fall, carrying over it an R. C. aqueduct 10 ft. by 7 ft. for a distributory crossing, and a 10 ft. roadway over the top of the aqueduct. Selection of site, design of the work, the foundation work, the work of pile driving in the foundations, the reinforcements and laying of the floor slab and other features of the work are described in detail. The most important feature of the work was the excavation of 20 ft. deep foundations below the spring level and laying of the floor concrete. The entire downstream floor is boxed in by 15 ft. interlocking sheet steel piles across the downstream end and on the flanks. Under the

crest are 20 ft. long interlocked sheet steel piles, and the upstream wing walls are founded on 20 ft. long sheet piles which branch off from the line of piles below the crest. The crest wall is of special shape, designed to give the maximum coefficient of discharge with minimum destructive action downstream. The length of the sheet steel piles, the floor and protection downstream, the shape and position of the crest and the best method of destroying energy and reducing scour downstream were determined by experiments in the hydraulic laboratory of the Punjab Irrigation Research Institute. The aqueduct is 10 ft. wide through which the distributary, which has a normal bed width of 33 ft., has been flumed. The flume with approach and delivery curves was designed on the basis of publication No. 6 of the Central Board of Irrigation on Fluming. A large number of pressure pipes were erected in the work in consultation with Rai Bahadur A. N. Khosla to collect data, which will be of immense value. Analysis of rates for the various items of work form the appendices to the paper.

#### A REGULATION GAUGE FOR HEADLESS CANAL METERS.

Paper No. 205.

Wilson.

Headless canal meters are venturi meters adapted for use in open channels and provided reasonable care is taken in their design, such meters are fundamentally sound discharge meters. In practice however, there are certain sources of error to which such meters are subject and in consequence, their reliability has been much questioned. The chief source of error is a deposit of silt on the upstream floor of the meter. This difficulty is overcome by adopting a special design to avoid silting and the method of design is indicated in appendix I of the paper. Elaborate observation and calculation are required in such meters and this limits their use for regulation purposes. For regulation purposes a simple direct reading corresponding to a definite discharge is essential. For this purpose an arrangement whereby a pointer moves over a series of equi-discharge curves on a plate from which the discharge can be read off direct, has been devised by the author. The mechanism is simple and is described in brief. The pointer is actuated by floats in the upstream and throat gauge wells and the name "double gauge" is given to the installation. The double gauge installation on the Eastern Canal, Punjab, is described in some detail. The design and setting of double gauge are described.

#### QUETTA RECONSTRUCTION PROGRESS, 1935-36.

Paper No. 206.

Boddington.

The paper describes the preliminary work in the rebuilding of Quetta Cantonment, consisting of clearance of sites, construction of labour camps and other sanitary arrangements, temporary

earthquake proof accommodation for personnel, etc. Some of the important features of design are given.

**EXPERIMENT ON PREMIX WORK IN MILE 35 G. T. ROAD  
(DELHI AMBALA) SECTION. Paper No. 207.**

Murari Lal.

This paper describes a number of experiments using premixed stone aggregate and consolidating it as water-bound macadam. A number of preparations manufactured by one of the Oil Companies were used in the premix work.

***Bombay.***

**IRRIGATION ADMINISTRATION REPORT, BOMBAY PRESIDENCY, PART I, FOR THE YEAR 1934-35.**

The report contains a general description of irrigation in the Presidency followed by detailed reports on each circle giving the weather and other conditions, information about floods in rivers and statistical details of area irrigated and working expenses. Brief descriptions of some works are also given. There are a large number of irrigation tanks in the Presidency. The Irrigation Research Division carried out the following work.—

1. Sub-soil survey and observation of sub-soil water levels.
2. Sub-soil drainage construction.
3. Irricultural research.
4. Hydro-dynamic research.

Hydro-dynamic research was carried out at Kha lakwasla (Poona) and includes experiments on the Hardinge Bridge at Sara, experiments on falls for the Central Board of Irrigation, experiments on silt exclusion, and experiments on Gibb modules. Study of the fundamentals underlying the reproduction of nature in hydro-dynamic models was also made.

***Sind.***

**NOTE IN REGARD TO THE CHANGES IN THE SUB-SOIL  
WATER TABLE WHICH HAVE TAKEN PLACE BETWEEN  
OCTOBER 1935 AND 1936 IN THE BEGARI AND  
SHIKARPUR INVESTIGATED AREAS.**

Bushby.

The Hydro-Isobaths plans for October 1936, and difference contours plan of October 1935-36 of the areas are discussed and commented upon. Mr. Bushby concludes that it is not possible to give any definite opinion as to the reasons of rises and falls in particular areas without cultivation figures, which are not available. A more detailed report based on the April comparison will take this into account.

WEEKLY STATEMENTS SHOWING RABI CULTIVATION  
AREAS IN SIND AS COMPARED WITH THOSE OBTAINED  
UP TO THE CORRESPONDING PERIOD OF LAST YEAR.

Statement for the week ending 13th March 1937 shows that area under Rabi this season is nearly 50,000 acres less than last year, the biggest decrease being in the Dad Division.

*Madras.*

REPORT ON THE OPERATIONS OF THE DEPARTMENT OF  
AGRICULTURE, MADRAS PRESIDENCY FOR THE YEAR  
1935-36.

Section IV deals with research. The research work in the Chemistry Section comprised soil survey of the Tungabhadra Project and analysis of soil samples to determine physical characteristics and water relations. A soil survey was also made of the Willingdon reservoir command to ascertain the cause of alkalinity which has developed in that area. Experiments with molasses as a fertilizer gave no encouraging results. In the crops section, economic and scientific studies of sorghum and millets were carried out. At Berhampur, broadcasting of rice has been proved to be as good as transplanting. Manurial trials at various stations revealed that phosphatic manures were ineffective, and green manures are better than mineral fertilizers. Applications of nitrogenous fertilizers over a dressing of green leaves gave definite increases in yield. Hybridization work was continued in Madras to evolve new strains of cotton. An irrigation experiment revealed that good crops of Cambodia cotton could be obtained by only 2 waterings applied after the monsoon and the best time of irrigation is in the second week of December and January.

The Imperial Council of Agricultural Research sanctioned a grant for research in sugarcane. Ratooning trials indicated that thin canes are better suited for ratooning than thick ones.

A programme of work for 1936-37 is given. Research on soils will include a study of influence of irrigation on soil characteristics with special reference to black soils, factors affecting the pH of soils, and preliminary study of the problem of amelioration of alkaline soils. Paddy research will include selection and hybridization, seasonal, and irrigation experiments. Sugarcane research will include manurial trials, irrigation trials and cultural methods. Study of water requirements of paddy, sugarcane and plantain will be undertaken.

THE VILLAGERS' CALENDAR 1937.

A Madras Agricultural Department publication containing a great deal of useful information for the agriculturist and the villager. The purpose of the Agricultural Department and the Agricultural College are described, and then follow notes on the eight Circles

of Agriculture in the Province by the respective Deputy Directors of Agriculture. These notes give the centres of work and headquarters of demonstrators of the Department doing propaganda work, lists of depots where seed is obtainable, kinds and prices of seeds available, and the research and other work in progress at the different agricultural research stations in the circle. The designations and addresses of officers to be approached for advice and assistance are given for each circle. The following are some of the other interesting items contained in the Calendar :—

Description of Nilgiris fruit gardens.

State loans and other facilities, and rules governing them.

General hints on management of a kitchen garden.

(The Calendar is also printed in vernacular.)

#### CALENDAR FOR 1936-37 OF THE COLLEGE OF ENGINEERING, MADRAS.

#### *Baluchistan.*

#### BRIEF NOTE ON IRRIGATION IN BALUCHISTAN.

Baluchistan is a barren mountainous country with an annual rainfall of about 7 inches, most of which falls during a few days in July and August. The resulting spates cause considerable damage and most of the water flows to waste through flood streams which have scoured down from 10 to 30 ft. below natural ground level. Water is the property of the individual or village. The man at the head of a stream may take all the water he can utilize, the next man as much of the balance as he requires, and so on. In the lower reaches of a stream therefore the supply is uncertain. Another indigenous method of irrigation is by means of 'Karez.' The Karez is an artificial underground channel which taps the underground supply available at the foot of the mountains. To excavate a karez a series of katcha wells are dug about 30 ft. apart on the alignment decided upon. By crude methods and without any modern implements these wells are joined at the bottom by small tunnels about 2½ ft. in diameter. The tunnel is graded to tap the supply at the head. The shaft at the head is often as much as 100 ft. and the tunnel a mile in length.

An irrigation department was formed in 1885 and the irrigation schemes constructed by the department are mentioned. A recent development is on the Khirtar Branch of the Lloyd Barrage Canals in Sind.

There is very little irrigation from wells in Baluchistan. In Kalat State a system of irrigation practised is building a number of bunds across a flood stream. The water is held up consecutively at these bunds until the bund breaches, when the water passes down to the next bund and so on.

*Indian States.***BRIEF NOTES ON IRRIGATION WORKS IN BENARES STATE.**

Describes three masonry weirs in the Benares State. Hewett weir over Karamnasa river was built in 1917. It is 610 ft. long and 45 ft. high. The Pathrawa weir was built in 1927. The Muzaffarpur weir was built 150 years ago by local workmen. It is 602 ft. long and 20 ft. high. Recently, inundation canals have been constructed from this weir. Photographs of the works are attached.

**KHAIRPUR LLOYD BARRAGE PROJECT, 1935-36, PARTS I & II.**

The system of irrigation in the Khairpur State prior to the completion of the Lloyd Barrage at Sukkur in 1932 was by inundation canals obtaining their supply from the river Indus which flows along the entire length of the State. One of the most important of the Sukkur Barrage Canals, the Rohri Canal, runs through the middle of the State dividing it into two and cutting off the inundation canal system. Before the Lloyd Barrage project was sanctioned the State objected to the construction of the Rohri Canal but finally agreed on condition that the State canals would be given water from the Lloyd Barrage. The Government of India appointed a Committee of the Central Board of Irrigation to consider the distribution of the waters of the Indus between the interested parties, of which Khairpur State was one, and a perennial water supply was allotted to the State. The State Engineer has therefore prepared, for the approval of the Government a complete project for two canal systems, one on either side of the Rohri Canal. The complete project, with a large number of plans and statements, is presented in these volumes.

**MYSORE AGRICULTURAL CALENDAR 1936.**

A publication of the Department of Agriculture, Mysore State. There is a large farm of 650 acres in the Irwin Canal tract for purposes of experiment, demonstration and seed supply. Some aspects of sugarcane cultivation in the Irwin Canal area are dealt with. Methods of control of sugarcane borers and other crop pests are described. Instructions about agricultural operations to be carried out each month are incorporated in the form of monthly notes.

**SUGARCANE CULTIVATION ON THE IRWIN CANAL FARM.**

Department of Agriculture, Mysore State, Bulletin  
No. 19.

Iyengar.

This pamphlet gives an account of sugarcane cultivation on the Irwin Canal farm, with particular reference to cost of production. The farm covers 650 acres, of which about 200 acres are utilized for cane growing. Experiments are being conducted to ascertain

at what stage the plant should be cut to give a satisfactory ratoon crop, and the influence of soil condition on a ratoon crop. Manurial requirement experiments are also being conducted. Information with regard to the ripening of cane planted or ratooned at different seasons is contained in an appendix.

#### DEVELOPMENT OF WATER FALLS IN THE MYSORE STATE.

Forbes.

A note by the Chief Electrical Engineer, Mysore State, describing the development of hydro-electric power schemes in Mysore. The Cauvery Power Scheme ranks amongst the oldest hydro-electric power schemes in the whole of Asia, and the generation of electric energy at the Cauvery Falls at Sivasamudram dates back to 1902. The initial scheme did not provide any storage but consisted of a diversion dam  $1\frac{1}{2}$  miles above the falls, two open channels to take the water to the forebay a mile below the falls, and a power house. The plant had a capacity of 3,600 kilowatts, and was subsequently increased to 9,000 kilowatts. Due to the discharge of the river falling to 100 cusecs, the plant was subject to prolonged stoppages. The next step in the development was the construction of the Krishnaraj Sagar reservoir with a capacity of 49,229 million cu. ft. which is now being used for irrigation and power generation. The capacity of the plant for power generation from the Krishnaraj Sagar is 45,000 kilowatts. Technical details of the equipment are given. Other schemes for hydro-electric power development are under investigation.

#### KRISHNARAJ SAGAR DAM, MYSORE.

An illustrated pamphlet describing the Krishnaraj Sagar scheme which consists of a dam across the river Cauvery and a canal called the Irwin Canal taking off from the north end of the dam. The objects of the scheme are to ensure a steady supply in the Cauvery for generation of power at Sivasamudram, and the irrigation of 1,20,000 acres of land. The dam is 8,600 ft. long, 140 ft. high, 110 ft. thick at bottom, and the waterspread area is 50 sq. miles. The quantity of masonry in the dam is 30 million cu. ft. The rear of the dam is laid out in gardens and terraces with fountains and water falls. The Irwin Canal after passing through hilly country for the first 25 miles runs through a tunnel piercing a range of hills. The tunnel is 9,200 ft. long, and 67 ft. to 150 ft. below ground level. The cost of the combined irrigation and power scheme is  $6\frac{3}{4}$  crores and the return at present is over 5 per cent.

#### EGYPT.

##### CLEAR OVERFALL WEIRS.

Butcher.

Ahmed Eff. Ragheb.

A publication of the Ministry of Public Works, Egypt, on research work at the Delta Barrage. The experiments are concerned with weirs



as water measuring and controlling devices. The distribution of water in Faiyum Province is effected by clear overfall weirs, as the general slope of the country is sufficient to provide the necessary drop in water levels at the weirs. The heads of branch canals are usually situated in groups, the crests of all being at the same level and the width of each weir being proportional to the area served by it. At the existing weirs, there was no certainty that the discharge per metre width of crest was the same for all widths of weir and the correctness of distribution was not assured. The problems requiring solution are stated as :—

1. To design a series of weirs involving as little modification as possible from existing types for which the discharge per metre width of weir is the same for all widths from 0.01 metres to 1.5 metres.
2. To determine exactly the discharge per metre width for all depths of water over the weirs between 0.05 to 1.00 metre.
3. To determine effect on discharge of departures from theoretical design necessitated by practical considerations.
4. To determine effect of velocity of approach on discharge.
5. To determine the best method of gauging depth of water over the weir.
6. To determine the effect of drowning on the discharge.
7. To consider modifications in design to reduce to a minimum the effect of drowning.

Experiments were carried out in the Delta Barrage experimental tanks which are fully described in an appendix. The results of all the experiments made are given in tables. In these tables the measured discharge for each experiment is compared with the discharge calculated from the standard formula finally deduced. The method of obtaining the standard formula was to plot the log of the discharge against log of depth over the weir for standard types of weir and to draw a mean curve through the points. The line obtained was straight for values of depth over weir from 0 to 0.14 and slightly curved for values of depth over 0.14. The formulæ are :—

$$q = 1.552 h^{1.54} \quad (h = 0 \text{ to } 0.14).$$

$$q = 1.956 h^{1.72} + 0.014 \quad (h = 0.14 \text{ to } 1).$$

where 'q' is the discharge and 'h' is the depth over the weir.

The experiments are discussed in detail and conclusions arrived at are :—

1. By correctly adjusting radius of corners to width of weirs a series of weirs of width from 0.1 metre upwards could be constructed to give the same discharge per metre width for all widths.

2. This discharge can be determined from the upstream gauge.
3. Velocity of approach may be neglected in practice.

**EXTRACT FROM ANNUAL REPORT OF THE MINISTRY OF  
PUBLIC WORKS (CAIRO) 1933-1934, "REMODELLING  
OF ASSIUT BARRAGE".**

The extract describes the experiments carried out to ascertain whether the fine dense Nile sand underneath the Assiut Barrage could be satisfactorily impregnated with cement or some other material to such a degree as to form an impermeable cut-off below the solid floor of the barrage. The experiments were made in a sand bank downstream of the barrage. The nature of the sand underneath the barrage was ascertained from samples extracted by drilling holes. A sand bank in which the sand was very nearly of the same nature as that underneath the barrage was selected. The following treatments were applied to the sand.

1. Injecting with cement grout under pressure of 100 lbs. per sq. in. through pipes.
2. Injecting alternately with cement grout and air diffusion under similar pressure.
3. Injecting alternately with cement grout and diluted silicate of soda, the latter acting as a lubricant to facilitate penetration of cement.
4. Injecting alternately with diluted silicate of soda and calcium chloride under a maximum pressure of 300 lbs. per sq. in.
5. Injecting with bitumen emulsion which is a mixture of bitumen and water emulsified with some chemical stabilizer. The pressure used was very small.

The injection pipes were lowered down some distance below the water table to approximate to actual conditions underneath the barrage.

The first three methods in which cement was used were absolute failures. The cement had not penetrated the sand interstices except in very coarse, almost gravelly sand. Injecting with chemicals was successful to some extent and the sand was solidified to such an extent that explosives were necessary to obtain samples. The defects of the method is the high pressure of injection which cannot be allowed under the barrage for fear of blowing up the floor. The bitumen emulsion gave satisfactory results. The sand however becomes watertight but not solid.

**MINISTRY OF PUBLIC WORKS, EGYPTIAN GOVERNMENT,  
ANNUAL REPORT FOR THE YEAR 1929-1930, PART II.**

The report describes the activities of the Irrigation, Physical, Mechanical and Electrical Departments for the year 1929-30, in Lower Egypt, Upper Egypt and the Sudan. The important works which were

in progress are the construction of Naga Hamadi Barrage, and the second heightening of the Aswan Dam. Hydraulic research includes problems of determination of pressure on gates, scouring below Assuan Dam and Naga Hamadi Barrage, and standing wave weirs for discharge measurements. The Physical Department is concerned with collection of hydrological data of the Nile basin, and rainfall and river gauging. The research work in this department includes evaporation investigations, silting of reservoirs, and model experiments of Aswan Dam sluices.

#### AFRICA.

##### REPORT OF THE DIRECTOR OF IRRIGATION, UNION OF SOUTH AFRICA FOR THE PERIOD 1ST APRIL, 1933, TO 31ST MARCH, 1934.

The report describes the work done in the Department in the year ending 31st March 1934. Hydrographic survey included establishment of river gauging stations, evaporation tank installations to compute evaporation losses from reservoirs, and observation on silt carried in suspension by rivers. One chapter is devoted to the work in progress consisting of several dams and canals.

##### REPORT OF THE DIRECTOR OF IRRIGATION, UNION OF SOUTH AFRICA FOR THE PERIOD 1ST APRIL, 1934, TO 31ST MARCH, 1935.

During the year under report the Agricultural Department embarked on a large scheme of anti-erosion work involving the construction of a large number of small dams for private owners. This relieved the Irrigation Department of their anti-erosion work in hand. For water supplies for anti-erosion work boreholes are probably of greater use than small dams specially in the laying out of scientific camps for the proper control of grazing. One of the important works is the Vaal River development scheme. Work on this scheme was started during the year. The scheme includes construction of a concrete gravity dam 1900 ft. long, 135 ft. high with a vertical upstream face and a downstream face which is stepped 0.7 to 1.0 ft. An earthen embankment 4,500 ft. long, 40 ft. wide at crest, upstream slope of 3 : 1 and downstream slope of  $2\frac{1}{2}$  : 1 will also be constructed. The distribution works consist of a division weir and canal. Other important works mentioned are the Olifants river dam, and the Pongola irrigation works. A feature of the dams is the stepped downstream slope.

##### THE BRITISH EAST AFRICAN METEOROLOGICAL SERVICE ANNUAL REPORT FOR 1935.

##### BRITISH EAST AFRICAN METEOROLOGICAL REPORT FOR NORTHERN RHODESIA, SEASON 1934-1935, No. 12.

## UNITED STATES OF AMERICA.

*Department of Agriculture.*

## FLOW OF WATER AROUND 180-DEGREE BENDS.

Yarnell.

Technical Bulletin No. 526, October 1936.

Woodward.

The bulletin presents the results of a series of experiments on the effects of 180° bends of square and rectangular cross section on the flow of water. The investigation was undertaken for the purpose of exploring the laws governing the changes in pressure and velocity in different parts of the flowing stream as the moving water undergoes transition from motion along a straight path to motion round a curve, and back again to a final straight line motion. This condition of transitional flow may be considered as representative of what exists whenever water flows in a crooked channel or whenever moving water meets a bridge pier or any other form of obstruction. The test apparatus is described in detail. The bend of 180° is of plate glass as also a length of 8½' each of the approach and discharge channels. The entrance tank and the remaining lengths of the approach and discharge channels are of wood. For measuring the periphery pressures in and adjacent to the bend, 22 piezometer openings were made in the bend. For measuring the velocities pitot tubes were used. Location of the piezometer and pitot tubes has been explained with diagrams. The test procedure and the actual tests are then described.

The main conclusions drawn from the experimental data are :—

- (1) A smooth bend acts as an obstruction disturbing the distribution of pressure and velocity in the cross section for a short distance above the bend.
- (2) As water approaches the beginning of a smooth bend, in the outside filaments the pressure increases and the velocity decreases. In the inside filaments the changes are reversed.
- (3) As water flows around a bend there must be higher pressure on the outside.
- (4) With uniform velocity distribution in the approach channel, the velocity of filaments along the inside wall of the bend are increased while velocities of filaments along the outside wall are reduced.

*Department of the Interior, Bureau of Reclamation.*

## MEASUREMENT OF IRRIGATION WATER :

FOURTH EDITION, JUNE 1935.

This is a publication by the U. S. Bureau of Reclamation on water measuring devices. The units of measurement generally in use in the west U. S. A. are the miner's inch, the second-foot and the

acre-foot. The value of the miner's inch is different in different states. The Bureau has therefore adopted the second-foot and the acre-foot as the units of measure. The measuring devices used by the Bureau are weirs, submerged orifices, and current meter gauging stations. A weir is used when the quantity of water is not too large and sufficient fall is available. A submerged orifice is used when the quantity of water is small and there is little available fall. Where the quantity of water is large, and sufficient fall is not available current meter gauging stations are used. A new method has lately been developed making use of a venturi flume called the Parshall flume, and in many cases it has proved an improvement over the older methods.

Three types of weir are adopted for measurement. These are the sharp crested and sharp sided contracted rectangular weir, the sharp crested suppressed rectangular weir, and the sharp crested and sharp sided Cipolletti weir. The definition and conditions for accuracy for each of these classes of weir have been discussed in detail and the formulas for discharge for each class with and without velocity of approach, have been considered. Instructions for construction of weirs and their maintenance and care are given. A series of tables are given in which discharges for different heads over the weir and different lengths of weir are given for all types of weirs. A table of coefficients to be used when allowance is to be made for velocity of approach is also given.

The principal type of orifice adopted for measurement is the vertical sharp edged, contracted, rectangular, submerged orifice. Conditions for accuracy have been discussed and the formulas for computation of discharges with and without velocity of approach are given. Construction, installation and care of such orifices are dealt with. Tables giving discharges for different heads and cross sectional areas of orifices are included. A description of current meters and their uses is given.

The improved venturi flume is a specially constructed flume so designed that the water flowing passes through the critical depth within the structure. The discharge can be determined by a single depth measurement. It is not yet widely used.

HYDRAULIC LOSS IN PIPE BENDS :

Watkins.

Technical Memorandum No. 517, May 14, 1936.

The memorandum explains the nature of the flow of water and the resulting hydraulic losses in pipe bends. The present state of knowledge does not permit accurate solution of bend loss problems. Sufficient information however, has been obtained from various laboratory experiments to estimate bend losses within reasonable limits. The paper provides data which is considered amply safe for conservative design. A sample problem has been given which illustrates the principles discussed.

**SHRINKAGE TESTS OF GROUT MORTARS :**

Vidal.

Technical Memorandum No. 520, April 27, 1936.

Smith.

To reduce shrinkage of mortar caused by cement hydration during the setting period, consideration was given to the intermixing of metallic aggregate with the grout mortar in the Boulder power plant construction. 'Embeco' is a specially prepared metallic aggregate manufactured in Cleveland, Ohio. Tests in the research laboratory of the manufacturer and Massachusetts Institute of Technology indicate that mortars containing this material in proper amounts would produce no shrinkage. In order to substantiate the above a brief but comprehensive series of tests was carried out, and the memorandum describes these tests, and results.

**FRICTION COEFFICIENTS OF CONTINUOUS INTERIOR**

Karelitz.

**AND RIVETED STEEL PIPES :**

Watkins.

Technical Memorandum No. 521, May 14, 1936.

Represents an attempt to establish the proper values of friction coefficients to be used in the evaluation of losses, and the design of large continuous interior and riveted steel pipes used as penstocks, outlet pipes, syphons, pump lines, etc. From the test data available, a series of curves were plotted against the corresponding values of Reynold's numbers for continuous interior and riveted steel pipes. From these charts the proper value of friction coefficient may be selected for the design under consideration.

**PRESSURE, ENERGY, AND FLOW CONDITIONS IN CHANNELS WITH HIGH GRADIENTS :**

Laufer.

Technical Memorandum No. 527, July 6, 1936.

(Translated from German).

This is a theoretical investigation of conditions of flow with steep gradients. A number of equations have been derived for hydrostatic pressure, potential energy and kinetic energy of a fluid particle in parallel flow over a steep gradient. Equations have also been derived for maximum discharge and dynamic capacity, and the range of Froude number for critical flow conditions has been mathematically investigated. The author concludes as below :

"It has been theoretically and experimentally demonstrated that for parallel flow with high gradients the pressure head in the interior of the liquid is no longer equal to the vertical distance from the surface but is significantly smaller. It follows that the  $q$ -line as well as the dynamic capacity are dependent upon the slope. The surface profile corresponding to the minimum dynamic capacity is both the boundary between shooting and streaming flow, and the surface profile for maximum discharge. The Froude number for this condition of flow can vary between 0 and 1 depending upon the slope."

From the equations evolved by the author, curves for discharge and dynamic capacity have been plotted for different slopes.

#### LABORATORY PROCEDURE IN TESTING EARTH DAM

**MATERIALS:** Technical Memorandum No. 533,

September 1, 1936.

The Bureau of Reclamation began making tests on earth dam materials in 1933. Some of the earlier work done was published in memorandum No. 410. The present memorandum is a revision of memorandum No. 410 and describes the improved equipment and the methods used in the laboratory since October 1934. The tests made in the Denver earth laboratory are (1) mechanical analysis (2) compaction and penetration resistance (3) moisture determination (4) specific gravity (5) percolation and settlement (6) consolidation (7) soluble solids (8) shear.

The memorandum describes the tests that are deemed the most important at the present time. A general summary of the tests has been given followed by details of test procedure for each of the tests mentioned above. Detailed drawings of equipment used form an appendix to the memorandum.

**VELOCITY DISTRIBUTIONS AND THE HYDRAULIC DESIGN OF SIDE-CHANNEL INTAKES AND SPILLWAYS, AND TAILRACES (CONTRIBUTION TO THE STUDY OF FLOWING WATER):** Technical Memorandum No. 536, October 12, 1936. (Translated from French).

Favre.

The paper is an account of research carried on in the hydraulic research laboratory attached to the Federal Polytechnic School, Zurich. It shows how general formulae concerning the stable flow of liquids have been established by the aid of the theorem of projection of momentum and tests on reduced models.

In the introduction the author says that to solve by computation the concrete problems which are presented in the domain of hydraulics, the engineer has available two distinct groups of theories. The first is hydrodynamics which deals with the movement of water in respect of each liquid particle. The second is hydraulics which deals with the motion of the mass as a whole. Hydrodynamics require the solution of complicated partial differential equations. Moreover, in the case of turbulent flow, the actual velocities and pressures differ from those obtained by computation, from the differential equations. In almost all the problems which require solution the engineer has to deal with turbulent flow. Hydrodynamic equations will not give him what he requires, namely, rapid solutions which correspond to the facts of natural phenomena. This explains the great development in the science of hydraulics. Hydraulics as stated above considers the motion of the mass as a

whole without troubling about the trajectories of the individual particles. By making some simple hypotheses about the motion of these liquid particles it is possible to establish rapidly and easily quantitative relations between the various factors in the flow of liquids. To establish these relations in conformity with observed facts, the use of experimentally determined coefficients is necessary. To carry out these experiments hydraulic laboratories have been built in various countries where experiments are conducted on reduced models.

The first chapter is devoted to the derivation of formulae concerning stable flow of liquids in channels and conduits with rectilinear axes but of any cross section. These equations show that the loss of energy in a flowing stream is due to three causes.

1. Development of turbulence at the contact with the sides.
2. Variation along the stream axis of the velocity distribution in the cross section.
3. Variation in discharge due to lateral inflow or outflow.

The second chapter gives a discussion of the results of model test on the tail race canal of a low head power plant.

The third chapter is devoted to variable discharge due to inflow and outflow.

The fourth chapter gives the conclusions arrived at after a study of the equations.

*Department of Commerce, National Bureau of Standards.*

#### CURRENT HYDRAULIC LABORATORY RESEARCH IN THE

UNITED STATES : Bulletin V-1, January 1, 1937.

This publication is compiled by the National Bureau of Standards, U. S. Department of Commerce, and contains the following information.

A list of current projects in the hydraulic laboratories of the U. S. A.

A list of completed projects with abstracts of each.

A list of foreign publications translated by different agencies.

A list of foreign pamphlets received by the National Bureau of Standards and available for loan.

Hydraulic research at the City and Guilds College, London University.

Hydraulic research committees and the work done by them.

Hydraulic research in the U. S. S. R. giving a list of projects under investigation.



Amongst the current projects in the U. S. A. may be mentioned the following :

- Efficiency tests of turbines, Boulder and other projects.
- Model studies of spillways and other outlet works.
- Model studies of flow through granular material.
- Study of hydraulic jump in a sloping channel.
- Model test of a laboratory venturi flume.
- River model tests.
- Transportation of bottom loads in open channels.
- Functional design of flood control reservoirs.
- Piping beneath masonry dams on earth foundations.
- Slope ratio study of a moveable bed river model.
- Pile foundation tests.
- Soil investigations with reference to levee construction.
- Mississippi River model studies.
- Flow in open channels.
- Flow of water round bends.

Amongst the completed projects may be mentioned :—

- Model studies of Cape Cod Canal and approaches.
- Model tests on rockfill dams for Passamaquaddy tidal power project.
- Model experiments for design of Boulder Dam.
- Model experiments for Imperial Dam and desilting works.
- Investigations on pipe bends.
- Velocity distribution in open channels.

*University of Florida, Agricultural Experiment Station.*

#### **ANNUAL REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1935.**

The report gives the work and investigations of the University of Florida Agricultural Experiment Station, with a list of bulletins issued during the year and summaries of contents. Experimental work in the Agronomy Department include crop rotation studies, manure studies, improvement of corn by selection and breeding, corn fertilizer experiments, etc. The Chemistry and Soils Department carried out research on concentrated fertilizers, effect of green manures on the composition of soil and effect of varying amounts of potash on soils. Other investigations mentioned are soil investigations, water control investigations on soils, cane breeding experiments, pasture investigations and cover crop investigations.

**FARMERS' COOPERATIVE ASSOCIATIONS IN FLORIDA :**  
Bulletin 276, March, 1935.

COTTON VARIETIES FOR FLORIDA : Bulletin 285, September 1935.	Carver.
A STUDY OF SOME TRACE ELEMENTS IN FERTILIZER MATERIALS : Bulletin 290, February 1936.	Gaddum. Rogers.
THE USE OF ZINC SULPHATE UNDER CORN AND OTHER FIELD CROPS : Bulletin 292, March 1936.	Barnette. Camp. Warner. Gall.
POTATO GROWING IN FLORIDA : Bulletin 295, April 1936.	Fifield.
THE REACTION OF ZINC SULPHATE WITH THE SOIL : Bulletin 298, June 1936.	Jones. Gall. Barnette.

*New Mexico Agricultural Experiment Station.*

FORTY-SIXTH ANNUAL REPORT OF THE NEW MEXICO  
COLLEGE OF AGRICULTURE AND MECHANIC ARTS  
1934-1935.

A list of publications issued during the year is given, some of which are as follows :—

1. Varieties of spring grains for irrigated areas of southern New Mexico.
2. Good cotton with a comparatively small amount of water.
3. Alkali determinations on Estancia valley soils and waters.
4. Effects of irrigation agriculture on soils.

Departmental reports of the various departments describing work done are given. In the Agronomy Department, the work includes variety tests of cereals, cotton investigations and fertilizer experiments. In the Biology Section investigations of various insect pests and diseases caused by them in various plants were carried out. The Chemistry Department is conducting an investigation on the effects of irrigation and cropping on soil profiles. The Irrigation Department is conducting experiments concerned with the measuring of irrigation water on cabbage. A study is also being made of the cause of rise of ground water in a portion of the country. The effect of fertilizers and frequency of irrigation on yields of cotton, and onion is being studied. Owing to drought, supply of irrigation water in the

Elephant Butte reservoir had decreased and two new pumping plants were installed for the experimental plots. These are described.

*Oklahoma Agricultural Experiment Station.*

**RESULTS OF THE REGULATION OF COTTON GINS AS PUBLIC**

UTILITIES IN OKLAHOMA : Bulletin No. 230, May 1936.

Ballinger.

This pamphlet discusses the effects of regulation by law of cotton gins in Oklahoma. The general conclusion arrived at is that the farmer patrons of the industry appear to have received comparatively little benefit from the regulation.

*Oregon Agricultural Experiment Station.*

**DRAINAGE AND IMPROVEMENT OF WHITE LAND AND**

SIMILAR WET LAND : Station Circular 83, June 1937.

Powers.

'White land' is the name given to a type of soil containing about 21 p. c. of clay and over 55 p. c. silt. It is a grey silty clay loam. About 200,000 acres of the Willamette Valley (U. S. A.) land are 'White land.' The Willamette Valley land requires to be drained in order to improve it. An experimental tile drainage system was installed at Oregon State Agricultural Experiment Station on a white land field adjacent to the station. Investigations of the most effective means of improving white land after tiling and of the value of lime, manure, rotation, and fertilizers for improvement of the land are in progress. A study has been made of outflow, water table conditions, and crop yields as affected by drainage.

The circular goes on to describe the principles of designing a system of tile drains, the digging operations, laying of the tiles, construction of surface inlets and silt basins, and the permanent outlet for discharging the drained water into the open stream.

The results of lime, manure and fertilizer experiments on the experimental field have also been discussed.

**MEANING AND USE OF WILLAMETTE SOIL SURVEY :**

Torgerson.

Station Circular 90, December 1928.

Powers.

During the past decade soil surveys of all Willamette Valley lands have been completed by the Agricultural Experiment Station. The Circular is intended to help farmers, land owners, and land appraisers, and county agents to make use of the fund of information accumulated, so that every farmer may learn to recognize and understand the characteristics of his farm soil, its composition, crops for which it is suitable, and fertilizer needs. The system of classification of soil has been described in detail. A diagram showing the distinguishing soil series characteristics of the Willamette Valley soils, and the sub groups and

major groups to which they belong has been included. Recommendation for the improvement of the different soils, their important requirements, the crops benefited, method of applying fertilizers are embodied in a table. An appendix gives the factors to be observed and recorded in the field when soil samples are taken for classification, the procedure of naming the soil, the manner of judging texture of soils, and directions for soil sampling.

**PROGRESS REPORT OF THE IRRIGATED EIGHTY-ACRE  
DEMONSTRATION FARM UNIT OF THE HARNEY BRANCH  
EXPERIMENT STATION 1927—1930 : Station Bulletin 270, October 1930.**

Shattock.

Hutchinson.

The irrigated 80 acre demonstration farm unit was established in 1927 to obtain information on the following points:

1. Cost of drilling and casing a well to irrigate an eighty acre tract.
2. Cost of installing and operating a pumping plant.
3. Cost of levelling an 80 acre tract for irrigation and constructing a distribution system.
4. Cost of producing standard crops under irrigation by pumping. The tract is irrigated by an 18" drilled well 85 ft. deep, cased to a depth of 60 ft. with 12 gauge galvanized steel casing. A turbine pump is used operated by a 25 H. P. Diesel oil engine.

For the 4 years, the average annual application of water has been 1.27 acre ft. per acre of crop. The average rainfall for the growing season has been 1.55 inches per annum. The crops grown gave a return on the capital investment of 11.6%, 5.6%, 47.9% and 8% for the four years 1927 to 1930.

The well, and the strata in which the well was drilled, are described. Cost of installation of the well, the pumping plant and levelling, etc., are worked out. A survey of the underground water resources of the region is in progress to determine the amount of underground water available.

**TWENTY-FIVE YEARS OF SUPPLEMENTAL IRRIGATION  
INVESTIGATIONS IN WILLAMETTE VALLEY : Station  
Bulletin 302, June 1932.**

Powers.

Frequent recurrence of unusually dry summers in the Willamette valley and the development of more intensive agriculture emphasize the importance of supplemental irrigation. Experiments to determine the value of supplemental irrigation in Oregon were started in 1907. Studies of the effects of irrigation on soil and crops were conducted, a ground water survey of the Willamette

valley has been carried out, and irrigation from deep wells has been successfully installed with the aid of a fund furnished by interested businessmen. A series of bulletins reporting the progress have been issued from time to time. The object of the present bulletin is to summarize the essential information on Supplemental Irrigation during the past 25 years and present it in a readily available form for information. The bulletin mentions the advantages of irrigation, the soils best suited to irrigation, crops which give best response to irrigation, the most profitable amount of irrigation, and the crop producing power of water. Results of a study of irrigated sheep pastures have been discussed. The suitable types of wells and pumps have also been described.

**MAINTAINING FERTILITY OF GRANDE RONDE VALLEY**

Powers.

SOILS : Station Bulletin 311, March 1933.

Richards.

The bulletin gives the results of fertilizer and soil improvement trials conducted jointly by the Oregon State Agricultural Experiment Station. The trials were planned to determine the soil needs for growing staple crops and the effect of various fertilizer applications on soils and crops, and to endeavour to conserve soil fertility by practising a rotation system with a legume crop. In these experiments profitable results have been obtained from sulphur and super-phosphates. Results of crop rotation experiments indicate that rotating with legumes such as peas or the use of annual sweet clover with spring wheat will increase the yearly income. Drainage and irrigation requirements, chemical analyses, management and maintenance are discussed. The maintenance of a good supply of soil organic matter is stressed. The methods of prevention of soil erosion have been discussed.

*Utah Agricultural Experiment Station.*

**MEASUREMENT OF IRRIGATION WATER : Circular 77**

(Revision of Circular 36), June 1929.

Clyde.

“ The object of the circular is to present in simple language the elements of water measurement. The circular includes a statement of the fundamental units used and a discussion of the common methods of water measurement together with tables and formulæ necessary for practical use. The material is in the main simply a compilation of State and Federal Publications on water measurement .”

The circular gives definitions of terms used in water measurement and some convenient relations between the units of flow. The devices for measuring irrigation water described in the circular are (1) weirs, (2) orifices, (3) rating flumes, (4) venturi flumes (5) volume meters. Sharp crested weirs of rectangular and trapezoidal sections, 90° triangular notch weirs, and suppressed

weirs are described, with discharge tables giving discharges for heads up to 1.5 ft. for all the above types. Discharge tables have also been given for submerged rectangular orifices. Standard dimensions and capacities of venturi flumes are given in a table, and free flow discharge for the venturi flume for heads from .2 to 2.5 ft. and throat widths 1 ft. to 10 ft. are also given.

*American Society of Civil Engineers.*

Proceedings. (See under 'Periodicals'.)

#### NEW ZEALAND.

PUBLIC WORKS STATEMENT, NEW ZEALAND, 1936.

Sample.

This is a report of the work of the Public Works Department of New Zealand. The works comprise railways, roads, buildings, irrigation, hydro-electric works, land improvement, telegraphs, water supply and drainage. Schemes under construction for irrigation, and hydro-electric works have been briefly described. Land improvement includes reclamation of sea beaches, a few drainage schemes, and river clearing and improvement schemes. The report is accompanied by numerous photographs of works and a large map of New Zealand.

#### AUSTRALIA.

##### HUME RESERVOIR.

An illustrated brochure containing a brief description of the Hume Dam in Australia and other appurtenant works such as a large steel girder bridge, and many roads. The dam comprises an earthen embankment 411 ft. long, a concrete structure 1,042 ft. long forming the spillway and outlet works, and another large earthen embankment on the other side 3827 ft. long, the total length of the dam being exactly one mile. The height of the concrete section is 150 ft. The outlet works consist of 7 needle valves and 7 Stoney gates. A number of interesting photographs are included.

##### THIRTY FIRST ANNUAL REPORT OF THE STATE RIVERS AND WATER SUPPLY COMMISSION, VICTORIA, 1935-36.

The report states that a Royal Commission on Water Supply was appointed in January 1936 to enquire into the amendment of the Water Act, and other matters concerning irrigation, drainage, etc., in the State of Victoria. The terms of reference of the Commission have been given in full. The Commission has made extensive inspections. Progress reports of the Commission have been issued and the enquiry is proceeding.

The report consists of three parts. Part I is a summary, giving the main points embodied in the report. Part II gives a detailed

account of the main works carried on or completed during the year. The most important work completed during the year is the Hume Reservoir. Minor works in other reservoirs are also mentioned. The works under Rivers and Reclamation Division comprised repairs to flood banks, building of new banks for flood protection, surveys of rivers requiring improvement, and the establishment of gauging stations on the principal rivers. There is a note on the problem of erosion which has assumed a serious aspect. Inspections made by the officers of the Commission in the catchment of the Upper Murray above Hume Reservoir showed that there is urgent need of an assured state policy of catchment preservation. Part III deals with administration and finance and is of purely local interest.

**REPORT OF THE WATER CONSERVATION AND IRRIGATION  
COMMISSION, NEW SOUTH WALES, FOR THE YEAR  
ENDED 30TH JUNE, 1936.**

The report gives the progress, financial results, etc., of irrigation areas established and controlled by State Irrigation. Research included watertable survey, soil investigations, investigation of irrigation practices, and investigation of areas for rice cultivation. Water conservation works and their operation are described in brief and the surveys and investigations undertaken are mentioned. Part VII deals with artesian and shallow boring. The deepest bore is 4,338 ft., and the greatest flow available is 1,107,870 gallons per day.

**TENTH ANNUAL REPORT OF THE COUNCIL FOR SCIENTIFIC  
AND INDUSTRIAL RESEARCH, COMMONWEALTH  
OF AUSTRALIA, FOR THE YEAR ENDED 30TH JUNE  
1936.**

This report describes investigations carried out by the Council, under the following sections :—

1. Plants.
2. Entomology.
3. Noxious weeds.
4. Animal Health and nutrition.
5. Soil.
6. Irrigation settlement.
7. Forest products.
8. Food preservation.

Soil investigations comprise a survey of settlements in the Murray River Valley, lime requirements of basaltic loam soils of the north coast, soil bacteriology, and chemical analysis of soils. Amongst irrigation investigations the most important is collection of data

on the important question of soil fertility. Other investigations undertaken are survey of free water in the soil in relation to condition of plants grown and irrigation methods, periodicity of irrigation, soakage investigations and relation of moisture content to permeability. A list of publications of the Council is given at the end.

## INTERNATIONAL CONFERENCES, ETC.

### SECOND CONGRESS ON LARGE DAMS.

#### QUESTION III.—SPECIAL CEMENTS FOR LARGE DAMS.

##### GENERAL REPORT.

Savage.

This pamphlet gives individual summaries of reports presented on Question III, and a general report on the subject. The general report discusses the use of Portland cement in large modern works and points out its disadvantages. The properties demanded of a cement suitable for massive hydraulic structures are enumerated. The principal requirements are low heat of hydration, high resistance to action of aggressive waters and other agents, and reduced tendency to cracking. Researches in various countries were carried out to evolve a suitable type of cement. The types of cement investigated and used in different countries are given. Factors contributing towards the behaviour of concrete in the structure are discussed and investigations as presented in the various papers emphasize that the use of special cement is but one of many important variable factors constituting the complex problems encountered in mass concrete construction. A table has been compiled showing the types of cement used in some recent dams. The various points requiring study in the problem of special cements for mass concrete are given at the end of the report.

The following reports on Question III presented at the Congress on Large Dams have also been received with the general report.

1. A survey of recent Scandinavian literature on special cements for dams and water-retaining structures. (In English.)
2. Special cements for hydraulic works in general, and large dams in particular, by Hoffman and Semenza. (In Italian.)
3. Interim Report on methods of testing cement in regard to heat of hydration, action on cement by water percolating through concrete, shrinkage, permeability and workability.



**QUESTION IV.—DESIGN AND WATERPROOFING OF  
SHRINKAGE, CONTRACTION AND EXPANSION JOINTS.  
GENERAL REPORT.**

Lapean.

This general report reviews in brief the papers presented on Question IV.

The consensus of opinion as gathered from the reports is that contraction joints should be provided in all straight masonry and concrete gravity dams. With respect to arch dams there is no unanimity of opinion. The spacing of contraction joints generally recommended is stated. The report then mentions the design and construction details of various types of joints, waterproofing and sealing, and grouting methods, as dealt with in the various reports. Some individual recommendations and conclusions of a few authors are quoted. In conclusion individual short summaries of all the reports on Question IV are given.

The following is a list of papers received with the general report :

1. Joint of concrete facing to canyon walls in Cogoti Dam. (Spanish, with English summary.)
2. Longitudinal contractions and expansions measured in a large concrete dam by Contessini (Translated into English from Italian.)
3. Shrinkage, Contraction, and Expansion joints in Norris Dam by Jones.

**QUESTION V.—RESEARCH WORK ON FACING MATERIAL  
FOR MASONRY AND CONCRETE DAMS.**

**GENERAL REPORT.**

Stanley.

The several reports submitted on this question contain interesting information on the methods developed for reducing or preventing percolation through the upstream faces. Greater attention has been given to this question in Europe than in America. The use of asphaltic or bituminous compounds is quite general in Europe. The opinions of various authors with regard to the methods of protection in general use are given. These methods include laying of bituminous mat, application of cement by the cement gun, the use of high quality cement on the upstream face, use of a metal coating, a facing of natural stone masonry, and a thin waterproof mortar coating. In America the meticulous methods used in Europe are not employed but careful control is exercised over selection and placing of materials. In important structures, the concrete on the upstream face is made of a richer mix. The reports submitted, in addition to outlining methods used, describe investigations of temperature control and frost damage in concrete. The points for discussion are :

1. To what extent and under what general conditions can present methods be considered satisfactory.
2. Effect of climate and need of protective measures.

Then follows individual summaries of all reports on Question V.

The following reports were received with the general report on Question V.

1. The facing of masonry and concrete dams, by Iwanow. (Bulgarian, with English summary.)
2. Resistance to cracking of surface layer of concrete gravity dams, by Nielaender (contribution of U. S. S. R. in English.)

#### QUESTION VI.—GEOTECHNICAL RESEARCH WORK ON FOUNDATION MATERIALS.

##### GENERAL REPORT.

Crosby.

The scope of Question VI includes geological studies of dam sites, geophysical and other aid to studies of dam sites, soil mechanics and methods of treatment of unfavourable conditions. The reports submitted cover one or more aspects of the question, give actual conditions found at dam sites, and the measures taken to meet the conditions. The subjects of the various reports are : geological investigations of dam sites, geophysical methods in studying dam sites, physical and chemical studies and tests and treatment of unfavourable conditions at dam sites. Some of the papers are mentioned and the principal points dealt with are elaborated. Topics for discussion which arise are :

1. Special problems in the investigation of dam sites in glaciated regions and on volcanic rocks.
2. Use of geophysical methods for locating faults and determining conditions of bed rock.
3. Methods of estimating seepage under dams on earth foundations.
4. Use of grouting or chemical injections in soils.

Individual summaries of all the papers received are given at the end.

The following papers have been received along with the general report—

1. Geotechnical studies of foundation materials, by Ehrenberg and Tiedemann. (In German with English summary.)
2. Engineering geology of dam sites, by Mead. (In English.)
3. Geotechnical tests of foundation materials, by Drouhin. (Algerian contribution in French with English summary.)
4. Geotechnical study of the foundation soils for dams, by Pagliaro (Translated into English from Italian).

#### QUESTION VII.—CALCULATION OF THE STABILITY OF EARTH DAMS.

##### GENERAL REPORT.

Creager.

15 papers were submitted on this question. Of these, 9 are devoted exclusively to the subject of stability of slopes of the dam. The others are devoted to general design, foundations, rolling of dams,

seismic studies, and descriptions. Two papers contributed by Sweden and the United States provide a solution of stability of slopes by an original mathematical treatment of the stresses. The subject matter of each paper is briefly outlined, and the points for discussion which arise are enumerated. In the end, individual summaries of all the papers submitted are given.

The following papers were received with the general report.

1. Calculation of the stability of earth dams, by Knappen.
2. Stability of earth dams, by Pagliaro. (English translation from Italian.)
3. Characteristics of materials used in earth dam construction—stability of earth dams in cases of reservoir discharge, by Mayer (English translation from French).
4. Proposed methods of calculating the stability of earth dams, by May and Brahtz.
5. Calculation of the stability of earth dams, by Ehrenberg (German with English summary).
6. Stability of embankment foundations, by Gilboy.

#### COMMUNICATION No. 5.

##### SILTING OF FOUR LARGE RESERVOIRS IN SOUTH AFRICA.

Lewis.

A communication to the Second Congress on Large Dams recently held in Washington. Two of the reservoirs are on tributaries of the Great Fish river and the other two on Sundays river. The two rivers are the most silty rivers in South Africa. The catchment area of these rivers is composed of soft and easily erodible rocks which have been subjected to erosion for a long time. There is no forest cover on the area. The rainfall in the area is from thunderstorms of short duration and violent nature. The above conditions combine to produce erosion resulting in a heavy charge of silt in the rivers. Probable methods of reducing deposits of silt in reservoirs have been considered. These are bottom flow tapping by small openings at deep levels, scouring out coarse materials, and dredging. The effect of the first method are discussed. It is considered cheaper to build new dams than to dredge. The capacity can be maintained by raising the dams and the financial aspect of this should be considered at the outset.

#### BULLETIN OF THE PERMANENT BUREAU, INTERNATIONAL COMMISSION ON LARGE DAMS, No. 5, DECEMBER 1936.

This Bulletin describes in brief the work carried out at the Second Congress on large dams held in the United States from September 7th to 12th 1936.

The International sub-committee of the International Commission on Large Dams, on special cements presented a report.

The Executive Committee decided to go ahead with drawing up the 'General Index of Large Dams.' The Committee recognised that the work of the Dictionary of the Association of Navigation Congresses was now sufficiently far advanced and decided to proceed immediately with the preparation of the Dictionary of Large Dams. There is a sub-committee of 8 members from 8 countries entrusted with this work. A bibliography of technical literature acquired by the Bureau is given at the end.

**WORLD POWER CONFERENCE : MINUTES OF THE MEETING  
OF THE INTERNATIONAL EXECUTIVE COUNCIL HELD  
ON JUNE 26TH AND SEPTEMBER 8TH AND 10TH,  
1936.**

The minutes of the meeting of the International Executive Council of the World Power Conference at the special session in London on June 26th, 1936 and the ordinary sessions in Washington on September 8 and 10, 1936 are given in this pamphlet. At the Berlin Conference it was decided to establish an organization for the purpose of interchanging test results and observations in nature in the field of hydraulic engineering. An International Association for hydraulic Structures Research has been formed. Prof. Fellenius on behalf of the above Association invited the World Power Conference to join the Association as a collective member. After discussion a resolution was passed by the Executive Council regretting the inability of the World Power Conference to accept the invitation. Two new National Committees, the Hungarian Committee and the Lithuanian Committee, were formed.

The second Chemical Engineering Congress was proposed to take place at Berlin in 1940 at the invitation of the German National Committee.

Japan invited the next Plenary session of the World Power Conference to be held in Tokyo in 1942. Formal acceptance of the invitation was postponed for a year.

**ILLUSTRATED TECHNICAL DICTIONARY, FRENCH, GERMAN,  
ENGLISH, SPANISH, ITALIAN, DUTCH.**

Published by the Permanent International Association of Navigation Congresses. This is Capter VIII of the Dictionary, and deals with Locks and Dry docks. All technical terms occurring in connexion with Locks and Dry docks are given in English and the other 5 languages, and are illustrated by sketches. A very useful reference book.

**TRANSACTIONS OF THE THIRD INTERNATIONAL CONGRESS  
OF SOIL SCIENCE, 1935—VOL. I: COMMISSION  
PAPERS.**

This is a volume of papers presented to the several Commissions of the Third International Congress of Soil Science. The papers are arranged in order of the Commissions as below :

- Commission I—Soil Physics.
- „ II—Soil Chemistry.
- „ III—Soil Microbiology.
- „ IV—Soil Fertility.
- „ V—Soil Genesis, morphology and cartography.

Sub-Commission Va—Alkali soils.

Sub-Commission Vb—Forest soils.

Commission VI—Application of soil science to land amelioration.

Sub-Commission VIa—Peat soils.

A few papers which may be of interest to irrigation engineers are mentioned below :—

1. The effect of irrigation and dry fallow on a heavy base saturated soil.
2. Electrodialysis as a means of measuring fertility.
3. Determination of phosphate and potash needs of soils by chemical analysis.
4. Fertilizer reaction, soil amendments and crop production.
5. Drainage properties of heavy soils.
6. Soil drifting in Canada.
7. Measurements of erosion by water, using electrical methods.

**OTHER PUBLICATIONS.**

**REPORT ON DELEGATION TO THE THIRD WORLD POWER  
CONFERENCE.**

**Griffin.**

The Third World Power Conference was held in Washington from September 7 to 12, 1936. The objects of the Conference, and the Congress of the International Commission on Large Dams are set forth, together with a history of the previous Conferences. At the Third World Power Conference there were more than 1700 recognized delegates. Mr. Griffin attended all executive committee meetings and meetings of the Congress on Dams, as the official delegate of the Government of India. He selected 50 of the papers written in English on subjects likely to be most useful. All papers will soon be available in book

form. The author describes a tour of inspection arranged for the delegates. The next Session is expected to take place in Japan and Mr. Griffin says that a strong delegation will be expected from India as the country is comparatively near.

#### ORIFICES FOR FLOW MEASUREMENT.

Engel.  
French.

(Reprinted from "Engineering" of October 16 and November 6, 1936, mentioned on page 27 of the Quarterly Bulletin No. 3). The paper deals with the measurement of discharge by orifices. A general flow equation has been derived by the authors based on the Bernoulli theorem. The discharge coefficient of orifices given in the German Standards, DIN 1952 is compared with results obtained by several experiments on 6 in. pipe lines based on the general equation referred to above. The discharge coefficient has also been expressed in terms of Reynold's number by one of the authors. The laminar, and transition to turbulent flow, with reference to discharge coefficient has also been discussed. The paper concludes with a few important instructions regarding the design and installation of carrier ring orifices.

#### THE ELECTROFLO HYDRAULIC LABORATORY.

Engel.

(Reprinted from the "Engineer", dated April 3, 1936 and mentioned on page 9 of Quarterly Bulletin No. 2). The paper commences with a short account of a few important hydraulic laboratories in Germany, France and America indicating their special features. It then goes on to describe the new hydraulic laboratory of the Electroflo Meters Limited. In addition to the routine work of calibrating venturi tubes and flow meters of all types this laboratory is intended for original research. Measuring devices for closed conduits have been carefully investigated during the last few years. Investigations are in progress on a model of a venturi flume recently constructed at Mogden in connexion with the West Middlesex sewerage works. The article concludes with a discussion on various dimensionless quantities which have to be considered in hydraulic model research on open channel flow, such as Reynold's number, Froude number, Weber number, and a new relationship introduced by the author which he calls the Boussinesq number.

#### STATEMENTS SHOWING THE NUMBER OF WELLS USED FOR IRRIGATION IN FASLI 1945 (MADRAS).

#### "GUNITE" IN BUILDING CONSTRUCTION.

Moore.

This is a paper read before the Indian Institute of Architects on December 6, 1934. The characteristics of "Gunite" and a few of the purposes for which it may be used are set forth. Gunite is the trade name of mortar formed of sand and cement propelled with great force by air pressure from a "cement gun". The mixture

is blown dry through a hose and water just sufficient for hydration is added at the nozzle, through a separate hose. The characteristics are: complete adhesion, absolute density, great strength, entire freedom from cracking, and resistance to fire. Each of the above characteristics is discussed. Results of compression tests of Gunitite and hand placed mortars are given. Re-inforced Gunitite has been used for water tanks subject to corrosion. Other uses of Gunitite in building construction are described. In America many large reservoirs have been constructed by excavation, and lining the bottom and sides with gunitite. A canal in Arizona 30 ft. wide and 20 miles long has been lined with gunitite over an area of 3 million sq. f.

**REPORT BY MR. A. P. WATAL, I.S.E., EXECUTIVE  
ENGINEER, JHANSI DIVISION, BETWA CANAL ON  
GUNITITE LINING—PAHUJ CANAL I.**

Describes the gunitite lining carried out as an experiment on 171.5 ft. length of the Pahuj Canal. The channel is of 9 ft. bed width, 4 ft. depth of water and side slopes of 2:1. The composition of the mortar, the plant used and the procedure of the work are described. The labour employed has been detailed and an analysis of cost of  $1\frac{1}{2}$ " thick gunitite lining has been given. The biggest item of the total cost of the slabs is its reinforcement which is as much as half the total cost.

**REPORT BY MR. A. P. WATAL, I.S.E., EXECUTIVE  
ENGINEER, JHANSI DIVISION, BETWA CANAL, ON  
GUNITITE LINING—PAHUJ CANAL II.**

The gunitite lining which was finished on 22nd September 1935 was inspected on January 15, 1936. Tell-tales fixed on December 13, 1935 were found to be cracked. The cracks in the gunitite lining are attributed to temperature variations. The surface on which gunitite was applied was not smooth but consisted of a number of serrations. The gunitite tightly gripped the serrations of the surface. When the temperature fell the lining tried to contract but this tendency to contraction was resisted by the perfect adhesion of the lining to the surface on which it was applied. The reinforcing fabric of the lining has been used to take up the temperature stresses under ordinary conditions. The adhesion of the lining to the surface caused additional tensile stress to be produced when the temperature fell. The reinforcing fabric is unable to stand these additional stresses and the lining develops cracks. To safeguard against the above, two methods are suggested: firstly, adopting a closer mesh light expanded metal reinforcement; secondly to spread a sheet of paper over the earthen surface, and spray the gunitite on the paper surface. The latter method is cheaper.

**COPY OF A D. O. NO. 66 FROM MR. A. R. POLLARD,  
CHIEF ENGINEER, IRRIGATION, GWALIOR, TO MR.  
S. T. H. MUNSEY, I.S.E., SUPERINTENDING ENGI-  
NEER, 4TH CIRCLE, U. P.**

Referring to cracks in the gunite lining of Pahuj canal, says that the cause of the cracks must be sought in the nature of the earth backing, and cracks at close intervals do not develop from temperature stresses alone. The instance of a channel is quoted where similar cracks were seen on the lining on one bank as a result of the sun drying the backing of clay on that particular bank. He thinks that if gunite lining is guarded against soil stresses till it attains a considerable portion of its ultimate strength, say for 21 days, there will be no trouble.

**COPY OF A D. O. FROM MR. S. T. H. MUNSEY, I.S.E.,  
SUPERINTENDING ENGINEER, IV CIRCLE, U. P.,  
TO MR. F. ANDERSON, C.I.E., I.S.E., CHIEF ENGI-  
NEER.**

The cracks in the gunite lining of the Pahuj canal are discussed. He favours the explanation of the cracks given by Mr. A. P. Watal. He considers it unwise to adopt this type of lining on any of the canals till more experience is gained.

**CORRESPONDENCE ON PROF. A. H. GIBSON'S ARTICLE  
"TIDAL AND RIVER MODELS" IN THE JOURNAL  
OF THE INSTITUTION OF CIVIL ENGINEERS SUPPLE-  
MENT TO NO. 8, OCTOBER 1936.**

**Blench.**

In the original paper Mr. Gibson, in discussing bed materials suitable for models says that when the question arises of the correct bed material for a model, theory ceases to be of much assistance and we have to rely on experiment. Theoretically the size of the bed material should be proportionally reduced in a model but such a material would be a fine powder and would not behave in the same way as the larger grains of the prototype. In many cases where the size of the bed material in a model is of the same order as in the river itself, conditions in the river were accurately reproduced in the model. In others, best results were obtained by changing the grain size. Mr. Blench has, with the help of the Lacey theory, explained quantitatively why some models give satisfactory results without a change in sand-size while others require a change. He has shown by an example how size of sand plays a part in correcting errors of scale in a model, and this explains the apparent discrepancy in the behaviour of models with respect to size of sand selected for the models. He further remarks that the Lacey relations should be used, after a full understanding of the very definite and limited physical conditions to which they apply.



**THE CAUSES OF FLOODS IN THE PUNJAB.****Gorrie.**

(Reprinted from the "Indian Forester", February 1937.)

This is a lecture delivered by Dr. R. MacLagan Gorrie of the Indian Forest Service in Lahore. The Punjab rivers fall in 2 groups, those rising from the great glaciers beyond the Himalayan range, and the smaller rivers rising on the nearer slopes of the main range. The heaviest monsoon rains fall on the lower, outer slopes of the Himalayas. When the surface on which the rain falls is of grass or forest with a thick plant cover growing as nature intended, the share of the rainfall which sinks into the ground is very much greater than when the surface is bare. The zone of worst flood danger is the foothills inside the Punjab Province and neighbouring Indian States. At present there is a continued deterioration of the hill grazing grounds and the floods are directly traceable to this continued deterioration. The hill grazier with his large herd of half starved cattle is mainly responsible for this deterioration. A drastic reduction of herds is needed.

Most water engineering projects take for granted the continued supply of water without paying very close attention to the conditions controlling it. No allowance is made for the deterioration brought about by the misuse of land through bad agricultural practices. It is very important to look after the catchment areas of our canal supplies, and the possibility of husbanding these supplies by the control of grazing and improved field cultivation should be carefully explored.

**NOTE ON SOIL EROSION IN THE PUNJAB.****Gorrie.**

(Reprinted from the "Indian Forester", February 1937).

Erosion in the lower foothills throughout the Punjab has been a subject of concern to Forest Officers for many years. Serious erosion is confined to the belt of the foothills formed by the Himalayan lower slopes, the Siwaliks and the other outlying rocky hills such as the Salt Range in the west, and Gurgaon hills in the east. This erosion is having a serious effect on canal water supplies and is a menace to the safety of hydro-electric plant. It is stated that the opinion held by canal officers is that the winter discharge of the Punjab rivers has definitely deteriorated. The Irrigation Research Institute is working on run-off figures for the Ravi river to give statistical proof of this opinion. Data on silt carriage of Punjab rivers collected by the Irrigation Branch show that the enormous load of silt carried by the Jhelum river has decreased the carrying capacity of the Upper Jhelum Canal by 40 per cent. A survey of erosion conditions was made in June 1936, in the Uhl catchment area. The chief causes of erosion were found to be bad cultivation on untterraced land, heavy grazing, and seasonal concentration

of migrant flocks. Much of the farm land below the Siwaliks has passed out of cultivation owing to the failure of existing wells, caused by lowering of the underground water table. Deforestation of the Siwalik slopes is a contributory cause of this lowering. The counter-erosion work done in the various areas mentioned is described in brief. Closure of grazing by law, afforestation with special plants, and building of earth and stone bunds to check ravining are some of the measures adopted. The main lines of attack of the problem suggested are to develop fodder resources for local live stock, and to improve standard of cultivation.

**HYDRAULIC LABORATORIES OF THE WEST, THEIR  
TECHNIQUE AND EQUIPMENTS.**

Bose.

(Reprinted from "Current Science" July 1934).

In this article, the author gives a short account of his experience during his last visit to the principal hydraulic laboratories of the West. He briefly describes the evolution of hydraulic laboratory practice to fulfil the urgent need felt by scientists of experiments to obtain a deeper insight into the workings of nature and to help the scientist in establishing theories. There are three distinct classes of hydraulic laboratories: purely scientific laboratories which are called hydrodynamic laboratories; the second class are purely practical and confined to the practical solution of concrete problems; and the third class are a combination of the above two. He takes a typical laboratory of each of the above classes and describes them and their workings. Of the hydrodynamic laboratories the best is stated to be that of Professor Prandtl in Gottingen; of the second class the best is said to be Prof. Rehbock's at Karlsruhe; of the third class, that of Prof. Meyer-Peter at Zurich is considered the best. Some of the experiments in progress at the laboratories are described in brief. In Prof. Prandtl's laboratory, experiments on turbulent flow in pipes, and on the boundary layer are in progress. In Prof. Rehbock's laboratory, experiments on the model of the river Rhine are in progress. In Prof. Meyer-Peter's laboratory, experiments on the silt carrying capacity of the Rhine, and determination of model rules for experiments with silt, are in progress.

The equipment of hydraulic laboratories is becoming standardized. The few well recognized principles observed in the installation of such laboratories are discussed by the author. Among the special problems which have been recognized to be amenable to model experiments, the author mentions the problems of silt in canals and rivers, and seepage in a porous medium. In Prof. Schaffernak's laboratory at Vienna model experiments on flow of water through sand are done more or less as routine work. The whole thing has been reduced to such exactitude that safety of a dam or weir, and seepage from a canal can be predicted with accuracy.

**NOTE BY MR. A. R. B. EDGECOMBE, EXECUTIVE  
ENGINEER AND IRRIGATION RESEARCH OFFICER,  
U. P., REGARDING THE USUAL METHOD OF DESIGNING  
A CHANNEL ACCORDING TO LACEY'S FORMULA.**

The usual method of channel design according to Lacey, and the formulae used, are given.

**NOTE IN REGARD TO THE CHANGES IN THE SUB-SOIL  
WATER-TABLE WHICH HAVE TAKEN PLACE BETWEEN  
JUNE 1935-36. AND OCTOBER 1935-36 IN KHAIRPUR  
STATE, SIND.**

Bushby.

Hydro-isobath diagrams for June 1936 and October 1936, and plans showing difference in subsoil water levels between June 1935-36 and October 1935-36, are attached. The isobaths for June 1936, and October 1936, show a rise of subsoil water level in the vicinity of Rohri canal which is attributed to intensive kharif cultivation, and higher discharge in October 1936, than in June 1936. There has been a slight improvement, as shown by the plan of difference in sub-soil water level in June 1935-36, which is attributed to lower gauge and less discharge of the Rohri Canal in June 1936, as compared with June 1935. The above refers to the area above Tando Mastikhan Fall. Below the fall the water table shows a rise; no pumps have been installed in this reach. An improvement is also shown in October 1936 as compared to October 1935.

**HOW THE WATER FLOWS FROM THE RIVER ON TO THE  
FIELDS.**

A broadcast talk by Mr. T. Foy, Chief Engineer, Bikaner State on January 22, 1937.

**DISCUSSION ON MR. E. W. LANE'S PAPER "STABLE  
CHANNELS IN ERODIBLE MATERIAL".**

Lacey.

The original paper was published in the proceedings of the American Society of Civil Engineers, November 1935. This discussion by letter was published in the May 1936 issue of the journal. Mr. Lacey says that engineers in India will be struck by the very different conditions obtaining in Colorado and the great alluvial plains of India. The problem of regime flow is much simpler in India than on the Colorado river. Kennedy's theory and Lacey's theory, which developed on the same lines, postulated that channels were flowing in an unlimited alluvial plain of the same silt grade as that transported. If a heavily charged channel is excavated in a medium other than the silt transported other factors come into play. Mr. Lane in the original paper says that on the Colorado canals, the non-silting velocity is considerably greater than Lacey's formulae would indicate. In this connexion Mr. Lacey says that the formula of silt factor  $f=8\sqrt{D}$  can only apply when the charge is a regime one, and was intended mainly to assist in computing critical velocities of natural streams in sand, shingle

or boulders rather than as a basis of design. The silt factor is proportional to  $V^2/R$  and it is this ratio which is required before channels can be designed. The silt charge on the Colorado is abnormal compared with Indian conditions. On some of the Colorado canals there are certain elements of flume traction which cannot be dissociated from channel behaviour, and there is no limit to the surcharge which can be forced down if slope is available. In alluvial rivers, the surcharge is thrown down, the rivers pick up a fresh charge, which they sweep forward. The remark of Mr. Lane that the capacity of a stream to transport silt in suspension is probably proportional to its turbulence, is illuminating. With flume traction and a heavy surcharge the turbulence required to drive forward the boundary layer would also occasion an abnormal suspended charge. The ratio  $V^2/R$  epitomises turbulence.

Mr. Lane has given a comprehensive list of factors affecting channel behaviour. Mr. Lacey thinks it preferable to write them down as dimensioned variables. He outlines in brief the method of dimensional analysis based on the Buckingham theory. The Chezy number, Reynold number and Froude number are discussed, and various relationships are derived with the help of his formulas. Finally he derives his fundamental shape formula. The relationship between the silt factor and the diameter clearly breaks down when there is a heavy silt charge, the fine silt behaving as coarse silt in a normal channel. In India where the problem of silt transportation is simpler Mr. Lacey's solution appears to fit a great mass of data. In Colorado where conditions are different and there are many disturbing factors practical design must depend on local conditions.

PROBLEMS OF ROAD RESEARCH. 1936.

Stradling.

Three lectures delivered before the Royal Society of Arts are presented in this publication. The lectures deal with the work of the Department of Scientific and Industrial Research carried out under the Road Research Board. The work is concerned with the engineering aspects of road construction. Lecture I deals with foundation studies including laboratory tests for compression and shear, and slope stability analysis. Concrete slab roads also are dealt with in this lecture. The concrete mix, accurate control and the use of vibrators are discussed. Lecture II deals with bituminous roads and road testing machines. Lecture III deals with road surfaces and their behaviour under load. Measurement of frictional resistance of road surfaces and impact tests are described.

THE DEPTH OF THE GANGETIC AND CUDDAPAH  
DOWN-WARPS IN INDIA.

Glennie.

(Reprinted from "Beitrage Zurangewandten Geophysik", Bd. 6, Heft 3, 1937).

Professor Ansel in a recent paper has analysed some of the results of the crustal warping hypothesis and has come to conclusions partly

favourable and partly adverse to this hypothesis. Professor Ansel's paper is discussed and it is concluded that the hypothesis first formulated by the writer in 1931, that warpings of the crustal layers extend down to a depth of about 30 kilometres, is justified by facts. The empirical method developed to apply this hypothesis is shown to give results which are sufficiently correct if the general paucity of data is taken into account.

#### THE NIRA VALLEY PROJECT.

This is a press note in the Nira Irrigation Project in Bombay which is nearing completion. The project serves a tract of land lying partly in the Poona and Sholapur Districts. This tract has been very liable to drought and famine, and was one of the first areas to be provided with protective works in the form of an irrigation scheme in early years. The early works which were completed 40 years ago consisted of a dam at Bhatgar and a canal 100 miles long taking off above a pick-up weir lower down on the Nira River. The scheme however, was found inadequate and a fresh one was sanctioned in 1912 providing for the raising of the dam by 60 ft. to increase its storage capacity. Technical difficulties in raising the dam proved insurmountable and an entirely new dam was proposed. This is the Lloyd dam at Bhatgar which was opened in 1928. It is over a mile long, 190 ft. high, 124 ft. thick at the base, and is built of rubble masonry in lime mortar. It conserves one of the largest reservoirs in the world, which stretches 17 miles and has a capacity of 24,200 million cub. ft. The dam has some special features such as shafts and galleries for inspection of the interior portion, and thermometers and other instruments to measure temperature, expansion, etc. The old left bank canal is being remodelled, and a new canal on the right bank 106½ miles long was constructed. Several photographs accompany the note.

LETTER DATED MARCH 5, 1937, FROM MR. GERALD LACEY TO THE EDITOR, "WATER AND WATER ENGINEERING" IN CONNECTION WITH AN ARTICLE ON "THE TIDAL MODEL OF THE RIVER GREAT OUSE AND THE WASH".

The tidal model of the River Great Ouse and the Wash has been given a record exaggeration of 1 to 41.7. Mr. Lacey thinks that if this model is successful in reproducing the scouring and silting in the actual river, a further addition to the present knowledge of scales of models will be made. He discusses the reasons advanced in the article for the current practice of distorting the scales in small models and considers that distortion is primarily necessary in order to produce turbulence and motion of the bed particles. Osborne Reynolds' equation connecting the model scale ratios with the working period ratios is discussed, and it is

stated that two equations are necessary if the model is to reproduce in addition to tidal cycles, the erosive and silting action of the river. The equations for scales of models evolved by Mr. Lacey in 1930, are applied to the Mersey models of Reynolds and the close agreement of the results are shown. The equations are then applied to the tidal model of the River Ouse and the wash and the exaggeration as adopted is shown to differ widely from that obtained by Mr. Lacey's equations. Mr. Lacey concludes with the remarks that it would be of interest to know what difficulties are met with in the model when silt and erosive action are allowed full play.

#### MEASUREMENT OF ABSORPTION LOSSES.

McKenzie-Taylor.

The two methods employed for measuring absorption losses are—

- (1) Observing the rate at which water sinks in an earthen reservoir or a small reach of a channel enclosed by bunds.
- (2) Discharge observations at the two sites between which the loss is to be estimated.

The criteria for judging the efficiency of the results are laid down and discussed.

The two methods of observing losses are then discussed in the light of the criteria and it is concluded that in the case of the first method, though susceptible of reasonable accuracy, its applicability to actual conditions of an earthen channel in flow is difficult to accept. The second method is definitely superior to the sinkage method in that it measures the actual loss and does not depend on conformity of model tank conditions to actual field conditions. The statistical aspects of the question of observing losses by the second method such as number of observations necessary, correlation of hydrographs at the two points of observations, are then discussed with reference to a report on certain observations taken on the Jhang Branch. The report gives details of the observations and the results are discussed at length. The conclusions are summarized at the end and it is emphasized that for good results the number of observations should be large, and that unless the discharges at the two points vary by an appreciable percentage, the results obtained, even by the best available methods, are uncertain.

COPY OF LETTER DATED MARCH 16, 1937 FROM MR. T.

BLENCH TO MR. GERALD LACEY.

Mr. Blench refers to his paper on Turbulent Flow in Channels read at the Punjab Engineering Congress in February 1937 and says he has managed to correct equation (17) of the paper to give the same formula for pipe and channel flow with rigid boundaries. He

goes on to show by a mathematical analysis how he arrives at the new equation and points out the advantages of his new development. He discusses Prandtl's Boundary Layer conception and thinks it is wrong to use his representation of the boundary layer theory to find boundary resistance.

**BENGAL RIVERS AND THEIR TRAINING. :** Bose.  
(Reprint from "Science & Culture", Vol. 1, No. 1, June 1935.)

For note see the issue of "Science & Culture", under "Periodicals".

**RESEARCHES ON THE HIGH DISCHARGES OF RIVERS.** Parde.  
(In French).

This deals with the methods of measuring river discharges, and the formulæ employed in the calculations.

**THE ROLE OF SNOW IN THE REGIME OF THE RIVER DRAC AT SAUTET.** (In French). Parde.

This deals with the effect of melting snows on run-off and river discharges.

**THE BIGGEST DISCHARGE CARRYING RIVERS OF THE WORLD.** (In French). Parde.

This publication, received from the author, discusses all the large rivers in the world in regard to rainfall and run off.

**SEASONAL VARIATIONS OF THE AMAZON.** Parde.  
(In French).

This extract from "Annales de Geographie" deals with the levels of the river Amazon throughout the year.

**EXPERIMENTS ON THE UTILITY OF ASPHALT AND TAR FOR SEALING AND STABILIZING EARTHEN STRUCTURES.** (In German).

This publication contains the following separate papers on the subject.

(1) **MAKING EARTHEN STRUCTURES IMPERVIOUS.** Kurzmann.

The author first mentions the two alternatives for making structures impervious.—One, of a solid core in the middle and the other of providing an impervious layer on the water side of the berm. Then he describes the clay and cement methods of treatment in both cases and describes their advantages and disadvantages. Concludes that in the light of experience both the clay and the cement treatment are unsatisfactory and that a mixture of bitumen used as a surface layer is very useful for the purpose.

(Translation is available in this office).

(2) **EXPERIMENTS WITH ASPHALT AND TAR FOR SEALING AND FASTENING EARTHEN STRUCTURES.** Mosslang.

(3) DETERMINATION OF SEEPAGE THROUGH AN EXPERIMENTAL EARTHEN CHANNEL LINED WITH ROLLED ASPHALT.

Wacken.

(4) BRIEF INTRODUCTION ON THE FIELD OF ASPHALT AND ITS USES IN ENGINEERING.

Ziegs.

### MAPS, BLUE PRINTS AND PHOTOGRAPHS.

#### *In India.*

MAP OF INDIA AND ADJACENT COUNTRIES, 1928.

#### *Bengal.—*

MAP OF BENGAL SHOWING IRRIGATION AND NAVIGATION CANALS AND DRAINAGE CHANNELS, ETC., (Second edition). 1925.

DAMODAR CANAL PROJECT : Photograph of Drainage Rapid.

DAMODAR CANAL PROJECT : Photograph of Kookooee Syphon.

DAMODAR CANAL PROJECT : Photograph of Fall No. 2.

DAMODAR CANAL PROJECT : Photograph of Anderson Weir and undersluices.

DAMODAR CANAL PROJECT : Photograph of Anderson Weir.

DAMODAR CANAL PROJECT : Photograph of Anderson Weir under sluices.

DIAMOND HARBOUR : Photograph of Sluice.

MOHUNPUR HEAD SLUICE : Photograph.

MIDNAPUR RIVER SUPPLY CHANNEL. Photograph of the channel and undersluice.

MIDNAPUR ANICUT : Two Photographs.

PANSKURA ANICUT : Photograph.

#### *Orissa—*

MAP OF ORISSA PROVINCE. 1936.

#### *United Provinces—*

GANGES CANAL : Cross Sections of Undersluices and Weirs at the Bhimgoda Headworks.

GANGES CANAL HYDRO-ELECTRIC GRID AND TUBE WELL SCHEME : Photographs of the general view and some views during construction of the Salawa Power House.

GANGES CANAL : Photographs of automatic gates installed at Salwa Power Station.

GANGES CANAL : Blue print illustrating two automatic gates at the Salawa Power Station. 1935.

GANGES CANAL : Blue print illustrating the automatic gates on main canal fall, Salawa Power Station. 1935.



**GANGES CANAL :** Blue print of Remodelling of Main Canal Fall at Salawa. 1935.

**SARDA CANAL :** Index Map. 1931.

*Punjab.*

**MAP OF PUNJAB, PUNJAB STATES AND DELHI.**

**GENERAL MAP OF IRRIGATION, PUNJAB, 1931-32.**

**PHOTOGRAPH OF SELF ACTING STREAM WHEEL.**

**LOWER CHENAB CANAL :** Photograph of Downstream view of fall at R. D. 37,000, Jhang Branch.

**LOWER CHENAB CANAL :** Photograph of Khanki Headworks under reconstruction. (The photo shows Bay No. 4 recently reconstructed to the Barrage type with a low crest).

**NAMAL DAM IN THE MIANWALI DISTRICT, PUNJAB :** Sketch Map of the location.

**NAMAL GORGE :** Blue print of the proposed dam at Lower Sulphur Spring : Details of Sluice Gates.

**NAMAL DAM :** Plan of 4 sluice outlets on left side and on right side at flow level.

**SUTLEJ VALLEY PROJECT :—**

**Ferozepore Headworks :** Photograph showing Barrage with its three canal heads taken on 15-6-29.

**Islam Weir :** Photograph showing installation of heavy steel gate in the Barrage. Oct. 1926.

**Panjnad Headworks :** Photograph of weir construction from behind left flank wall. 30-11-30.

**Panjnad Headworks :** Photograph of main weir downstream alterations finished concreted Tarangars. 22-5-30.

**Panjnad Headworks :** Photograph showing the construction of Panjnad Headworks.

**Panjnad Headworks :** Aerial photograph of the headworks and canal heads after completion.

**UPPER BARI DOAB CANAL :** Photograph showing Tughial Girder Bridge and Rapid, Main Line, from downstream left bank.

**UPPER CHENAB CANAL :** Detailed section of V. R. Bridge and Aqueduct for Sikhawala Distributary at R. D. 1000 of D. D. Channel, Sheikhpura Division. 1935.

**UPPER CHENAB CANAL :** Details of combined Aqueduct and Fall at R. D. 1000 of D. D. Channel, Sheikhpura Division. 1935.

**UPPER CHENAB CANAL :** Plan of combined aqueduct and a fall at R. D. 1000 of D. D. Channel, Sheikhpura Division. 1935.

UPPER JHELUM CANAL : Photograph of downstream view (from left) of the Mangla Regulator. 15-4-18.

WESTERN JUMNA CANAL : Dadupur Silt Excluder : General Plan of the Alternative Design. 5-9-35.

WESTERN JUMNA CANAL : Dadupur Silt Excluder : Section through tunnels and vanes. 24-8-35. Alternative design.

WESTERN JUMNA CANAL : Dadupur Silt Excluder : Tunnel portals and road bridges. 5-9-35. Alternative design.

WESTERN JUMNA CANAL : Dadupur Silt Excluder : Two photographs.

WESTERN JUMNA CANAL : Photograph of Dadupur Dam.

*Bombay—*

MAP OF DECCAN AND GUJERAT TO ACCOMPANY THE IRRIGATION ADMINISTRATION REPORT, 1932-33.

PLAN SHOWING A SILT ABRADER 4' IN DIAMETER AND 4'-1½" HIGH. (Details of paddles consisting of 3 tiers of 3 blades each are also shown. Each tier is set 40° from the other two.)

PLAN SHOWING HYDRODYNAMIC RESEARCH STATION AT LAKE FIFE, POONA.

GODAVARI RIGHT BANK CANAL : Photograph of the Head Regulator at Nandur Madhmeshwar.

NIRA CANAL : Photograph of waste weir of the Lloyd Dam in action.

NIRA CANAL : Photograph of the top view of the Lloyd Dam from south end.

NIRA CANAL : Photograph of the Lloyd Dam at Bhatgar.—Distant view showing downstream face of the dam.

NIRA CANAL : Photograph of the Lloyd Dam lowest sluices (one fitted with disperser and one without) in action. (This photo accompanies the official press note regarding Nira Valley Development which has been published in the newspapers).

NIRA CANAL : Photograph of the automatic waste weir in action at the Lloyd Dam. (This photograph also accompanies the press note).

NIRA CANAL : Upstream view at Venturi Meter in mile No. 1 of Nira Right Bank Canal. (This photo also accompanies the press note).

NIRA CANAL : View of the upstream face of the Lloyd Dam looking north. (This photo also accompanies the official press note).

*Sind—*

GENERAL MAP OF SIND SHOWING ALL AREAS TO BE IRRIGATED BY LLOYD BARRAGE AND NEW CANALS AND EXISTING CULTIVATION IN AREAS NOT COMMANDED BY THE BARRAGE, TO ACCOMPANY THE IRRIGATION ADMINISTRATION REPORT 1931-32.

LLOYD BARRAGE : View of Barrage, left and right bank regulators and dredgers.

LLOYD BARRAGE : Photographic survey of the Lloyd Barrage. October 1933.

LLOYD BARRAGE : Photograph of the Barrage view from downstream.

DADU CANAL : View of a portion of Johi Pat before functioning of the Barrage canals.

DADU CANAL : View of the same portion (as mentioned above) of Johi Pat after functioning of the Barrage canals.

DADU CANAL : Record plan of general layout for Water Lift at R. D. 6000, Northern Dadu Division. 1933.

DADU CANAL : Plan of Elevating Water Wheels to be erected at R. D. 22500, Northern Dadu Canal. (Discharge is 16 cusecs). 1933.

DADU CANAL : Record plan of general layout for water lift at R. D. 29358, Northern Dadu Division. 1933.

JAMRAO CANAL : Photograph of Jamrao Head Regulators and undersluices.

JAMRAO CANAL : Photograph of panoramic view of weir regulator with Jamrao head regulator in the background.

ROHRI CANAL : Index Plan of Rohri Canal in Khairpur State.

ROHRI CANAL : Condensed longitudinal section of Rohri canal from R. D. 0 to R. D. 3,28,450.

ROHRI CANAL : Cross sections of bores up to line K 29 in Khairpur State.

ROHRI CANAL : Particle size distribution curves, Rohri canal sand (from bed) R. D. 70,000 and 85,000 (Tests made at Research Institute, Punjab, Lahore).

ROHRI CANAL : Velocities observed on 5-5-34 at R. D. 8,15,000 of Rohri Canal.

### *Madras.*

INDEX MAP SHOWING THE SYSTEMS IN CHARGE OF THE IRRIGATION BRANCH, P. W. D., MADRAS. 1929.

### *Ajmer-Merwara and Rajputana.*

MAP OF AJMER-MERWARA AND RAJPUTANA (Ajmer-Merwara District, Jaipur and Kishangarh States) 1933.

MAP OF AJMER-MERWARA AND RAJPUTANA (Ajmer-Merwara District, Jodhpur and Udaipur States) 1934.

MAP OF AJMER-MERWARA AND RAJPUTANA (Ajmer-Merwara District, Kishangarh, Shahpur and Udaipur States) 1934.

MAP OF AJMER-MERWARA AND RAJPUTANA (Ajmer-Merwara District, Bundi, Jaipur, Kishangarh, Shahpur and Udaipur States) 1933.

MAP OF AJMER-MERWARA AND RAJPUTANA (Ajmer-Merwara District and Kishangarh State) 1932.

**MAP OF AJMER-MERWARA AND RAJPUTANA** (Ajmer-Merwara District and Jodhpur State) 1931.

**MAP OF AJMER-MERWARA AND RAJPUTANA** (Ajmer-Merwara District, Jaipur, Jodhpur and Kishangarh States) 1933.

**MAP OF AJMER-MERWARA AND RAJPUTANA** (Ajmer-Merwara District, Jodhpur and Udaipur States) 1935.

*Other Indian States.*

*Bahawalpur State—*

**COMPLETION PLAN OF PROPOSED ADDITIONS TO 1-20 FT. GIRDER BRIDGE No. 154 AT MILE 129/8-9 TO PASS SADIQIA FORD-FEEDER ON S. M. A. B. T. I. SECTION AT R. D. 23420 S. F. FEEDER. 1935.**

*Baroda State.*

**MAP OF BARODA STATE SHOWING IMPORTANT IRRIGATION WORKS, ETC.**

*Benares State.*

**MAP OF BENARES STATE WITH INTERVENING TERRITORY.**

*Bikaner State.*

**MAP OF BIKANER STATE SHOWING THE IMPORTANT IRRIGATION WORKS.**

*Cambay State.*

**MAP OF CAMBAY STATE. 1932**

*Gwalior State.*

**GWALIOR GOVERNMENT CANAL.**—Photograph of earthwork trimmed and consolidated.

**GWALIOR GOVERNMENT CANAL.**—Photograph of B. R. C. fabric in place against tamped earth channel: shooting in foreground.

**GWALIOR GOVERNMENT CANAL.**—Photograph of gunite being shot against earth: all gunite reinforced with B. R. C. fabric 6" squares 3/16" wires.

**GWALIOR GOVERNMENT CANAL.**—Photograph of section being cured.

**GWALIOR GOVERNMENT CANAL.**—Photograph of completed section against earth.

**GWALIOR GOVERNMENT CANAL.**—Photograph of masonry section through hilly country.

**GWALIOR GOVERNMENT CANAL.**—Photograph of an aqueduct before treatment.

**GWALIOR GOVERNMENT CANAL.**—Photograph of long aqueduct.

**GWALIOR GOVERNMENT CANAL.**—Photograph of downstream end of temporary dam showing entry of steel sluice, canal being kept flowing throughout operation.

GWALIOR GOVERNMENT CANAL.—Photograph of back of temporary dam taken from a section isolated from the water.

GWALIOR GOVERNMENT CANAL.—Photograph of steel sluice in hilly country.

GWALIOR GOVERNMENT CANAL.—Photograph of steel sluice carried on an aqueduct under treatment.

*Hyderabad State—*

MAP OF HYDERABAD STATE, 1928.

*Khairpur State—*

Index Map of Khairpur State showing the alignment of State canals. 1935.

*Baluchistan—*

PLAN OF CONCRETE CORE WALL OF THE SPIN KAREZ DAM IN BALUCHISTAN 1935.

*Burma—*

MAP TO ACCOMPANY THE BURMA P. W. D. IRRIGATION BRANCH REPORT FOR THE YEAR 1933-34.

MAP OF BURMA SHOWING MONSOON CURRENTS AND THE RAINFALL.

MEIKTILA LAKE PROJECT.—Capacity curve for Meiktila North and South Lake for 1898, 1923, 1932 and 1935.

MEIKTILA LAKE PROJECT.—Cross section of North Bund showing observations of hydraulic gradient for December 1926.

MEIKTILA LAKE PROJECT.—Cross section of South Bund showing observations of hydraulic gradient for December 1926.

MEIKTILA LAKE PROJECT.—Cross section of South Bund showing observations of hydraulic gradient for November 1935.

PAUNG CHAUNG AQUEDUCT.—Photograph.

TAGUNDAING TANK PROJECT, MEIKTILA IRRIGATION DIVISION.— Cross section showing hydraulic gradient pipes as fixed at R. D. 450.

*Miscellaneous—*

PHOTOGRAPHS OF THE OFFICERS AT LIEUTENANT-COLONEL G. COVELL'S DEMONSTRATION IN CONNECTION WITH ANTI-MALARIAL MEASURES IN DELHI GIVEN TO MEMBERS OF THE CENTRAL BOARD OF IRRIGATION AND OTHER OFFICERS WHO ATTENDED THE 7TH ANNUAL MEETING OF THE BOARD IN DELHI IN NOVEMBER 1936.

NEWSPAPER CUTTINGS.

MODERN METHODS OF CONCRETE CONTROL—December 25, 1936.

Brief review of a paper read by Mr. A. Vasudevan, Assistant Chief Controller of Standardisation, Railway Board, under the auspices of the North-West India Centre of the Institution of Engineers (India).

**WOOD'S CHALLENGE TO STEEL AND CONCRETE**—December 25, 1936.

Brief review of a booklet issued by the Forest Research Institute, Dehra Dun.

**IRRIGATION IN BOMBAY PRESIDENCY : DECCAN AND GUJERAT AREA NOT COMPACT.**—December 31, 1936.

Review of the Administration Report of the Irrigation Works in the Bombay Presidency for 1934-35.

**ELECTRICAL DEVELOPMENT IN THE UNITED PROVINCES.**—January 1, 1937.

Refers to a United Provinces Government communiqué concerning the attitude of the Government towards further applications for the generation and distribution of electricity in the light of the remarkable developments which have taken place, particularly in regard to bulk supply, during the last seven years.

**OFFICIAL PLANS FOR FURTHER ELECTRIFICATION IN U. P. : ENERGY FOR AGRICULTURAL PURPOSES : CHEAP POWER FOR SMALL INDUSTRIES AND PUMP IRRIGATION.**—January 1, 1937.

Same as above.

**NEED OF SURVEY OF INDIA'S FOOD PRODUCTION : GRAVE POPULATION PROBLEM : DANGERS AHEAD : STEADY INCREASE IN BIRTH RATE.**—January 5, 1937.

Review of the Annual Report of the Public Health Commissioner with the Government of India for 1934.

**ELECTRIFICATION OF U. P. : BIG DEVELOPMENTS PLANNED : GRANT OF LICENCES : AIDING INDIA'S COTTAGE INDUSTRIES.**—January 5, 1937.

Deals with the remaining portion of the United Provinces Government communiqué part of which has been published in the issue of January 1, 1937.

**IRRIGATION IN THE UNITED PROVINCES.**—January 8, 1937.

Review of the Report of the U. P. Government on the Working of the Irrigation branch of the P. W. D. for 1934-35.

**SILTING OF RESERVOIRS.**—January 8, 1937.

Mentions briefly some results of the investigations on 'Siltng of Reservoirs' by the United States Soil Conservation Service of the Department of Agriculture.

**TUBE WELLS AND AIR-LIFT PUMPING : A PAPER READ AT BENARES.**—January 8, 1937.

Notes on a paper entitled "Some Notes on Tube Wells and Air-Lift Pumping" presented by Mr. C. H. Vora, Executive Engineer, Baroda State, at the 17th Annual Conference of the Mechanical Engineers' Association (India) held at Benares in December 1936.

**U. P. ELECTRICITY—January 8, 1937.**

Deals with the communiqué of the United Provinces Government.

**SOIL SURVEY IN INDIA : SIR JOHN RUSSELL ON ITS IMPORTANCE.—January 8, 1937.**

Speech at the joint meeting of the Agricultural and Zoology sections of the Indian Science Congress. The speaker referred to the need for co-ordination between the engineer and the geologist in irrigation schemes and said that most of the failures in schemes of irrigation were due to an imperfect understanding of the nature of the soil.

**REDUCING COSTS OF ELECTRICITY, HOW WOOD CAN HELP. SPECIAL POLES FOR POWER DISTRIBUTION.—January 12, 1937.**

A Press Note regarding investigations of the Forest Research Institute, Dehra Dun, in this connection.

**PUBLIC HEALTH DURING 1934 CHIEF CAUSES OF MORTALITY AND REMEDIAL MEASURES.—January 16, 1937.**

A Press Note on the Report of the Public Health Commissioner with the Government of India for 1934. Among other causes of mortality is mentioned the malarial epidemic, for which canals are also considered responsible to some extent, as they cause the subsoil water level to rise.

**FACILITIES FOR TRAINING OF ENGINEERS, U. P. GOVERNMENT APPOINT COMMITTEE.—January 16, 1937.**

A committee has been set up by the United Provinces Government "to advise the Government as to the measures that can and should be adopted with a view to provide facilities for effective practical training with or without payment of wages or remuneration, for students and ex-students of colleges and schools both Government and recognised, of civil, mechanical and electrical engineering in the United Provinces." Sir William Stampe, Kt., C.I.E., I.S.E., Chief Engineer, Public Works Department, Irrigation Branch has been appointed as the Chairman.

**LAND IMPROVEMENT AND RECLAMATION : VALUE OF MOLASSES AND OIL-CAKES : PROF. DHAR'S ADDRESS TO NATIONAL ACADEMY OF SCIENCES.—January 17, 1937.**

Describes the usefulness of molasses and press mud for reclaiming alkali lands.

**PERIYAR WATER DISPUTE : SIR DAVID DEVADAS'S AWARD RECEIVED.—January 22, 1937.**

Sir David Devadas is arbitrator on behalf of the Madras Government. The award of Dewan Bahadur V. S. Subramania, the arbitrator

on behalf of Travancore Government—the other party to the dispute—is still awaited. The dispute is whether Madras is entitled to use the water of the Periyar Reservoir for generation of electric power.

**INDIA'S IRRIGATION PROBLEMS : SCIENTIFIC RESEARCH :  
VALUABLE DISCOVERIES BY PUNJAB INSTITUTE.—  
January 23, 1937.**

Review on the Annual Report of the Punjab Irrigation Research Institute for the year ending April 1936. Most important and interesting investigation is the reduction of seepage from canals by the treatment of the bed with sodium carbonate.

**RESEARCH VALUE IN IRRIGATION : SOIL SURVEYS : PUNJAB  
SCIENTIFIC DEVELOPMENTS.—January 23, 1937.  
Same as above.**

**RESEARCH DEVELOPMENT : IMPROVING INDIA'S CROP  
OUTPUT : SOIL SCIENCE : ADVISORY BOARD TO MEET  
AT DELHI.—January 23, 1937.**

Remarks on the agenda for the meeting of the Advisory Board of the Imperial Council of Agricultural Research to be held from January 25 to 30.

**PUNJAB IRRIGATION RESEARCH INSTITUTE : PREVENTION  
OF LOSSES BY SEEPAGE IN CANAL BEDS : WORK BEING  
DONE IN DIFFERENT SECTIONS.—January 23,  
1937.**

Review on the Annual Report of the Punjab Irrigation Research Institute for the year ending April 1936. Photographs are included.

**JAPAN BUILDS SECOND LARGEST RESERVOIR.—January  
26, 1937.**

Preparations for the construction of the largest reservoir in Asia and the second largest in the world are now in progress at Ogochi, thirty miles North-east of Tokyo. The reservoir is for water supply to the city of Tokyo. The completed facilities will be capable of supplying Tokyo with nearly a thousand million gallons of water a day. The total cost will be over £20,000,000.

**TEST TRACK FOR ROAD SURFACES : RESEARCH PLANS.—  
January 26, 1937.**

**WATER SCARCITY IN QUETTA : LONG-STANDING PROBLEM  
SOLVED : PROJECT OF A DAM'S CONSTRUCTION · PRE-  
LIMINARY WORK STARTED RS. 8,00,000 SCHEME.—  
January 26, 1937.**

Construction of the Spin Karez Dam will be shortly taken in hand. It will be 1,800 feet long and 84 feet high, made of earth, with a clay puddle wall in the middle. The lake formed by it will store rain water and will have a capacity of 16,20,00,000 cubic feet of water. It will cost about 8 lakhs of rupees.



**PLANT PATHOLOGIST OF SUDAN TO STUDY IRRIGATION  
WORKS IN INDIA.—January 27, 1937.**

Mr. Andrews, Plant Pathologist of the Agricultural Research Service of Anglo-Egyptian Sudan has arrived and will stay in India for four months and will visit agricultural centres. He will submit his recommendations to the Agricultural Research Service, for the development of agriculture, particularly cotton. Conditions in Hyderabad (Deccan) are similar to Sudan as regards black cotton soil.

**PUNJAB LETTER : CONSERVATION OF WATER SUPPLIES :  
DRASTIC ACTION NEEDED : ENORMITY OF RURAL  
INDEBTEDNESS.—January 27, 1937.**

Address of Dr. R. MacLagan Gorrie to the Lahore Rotary Club on "The Sources of Punjab Water Supplies". The speaker says that flood control must start not with expensive engineering along big rivers but with rain drops and rivulets far up in the hills. He also says that if drastic action for the conservation of water supplies is not taken fairly soon the "vaunted Punjab canal system will in a few decades be merely a lot of shallow ditches half buried in sand".

**ROAD SURFACE PROBLEM IN INDIA : TEST TRACK UNDER  
CONSTRUCTION : EXPERIMENTS TO BE MADE IN CAL-  
CUTTA.—January 27, 1937.**

**U. S. A. ENGINEERING PROJECTS : DELEGATE'S TOUR :  
BENGAL OFFICIAL ON HIS EXPERIENCES.—January  
31, 1937.**

Mr. F. C. Griffin's account of his visit, as official delegate of the Government of India, to the Third World Power Conference held in Washington in September 1936. Among the items of interest visited was an all-electric farm.

**SCIENCE'S AID TO AGRICULTURE : PUNJAB EXPERIENCE :  
GOVERNOR'S ADDRESS TO LYALLPUR STUDENTS.—  
January 31, 1937.**

**AIR INSPECTION OF TUBE WELLS : SIR JOHN RUSSELL'S  
450 MILES FLIGHT.—February 4, 1937.**

Inspection of the Ganges Grid Tube Well Scheme in the U. P.

**OUR TRAVANCORE LETTER.—February 4, 1937.**

*The Pallivasal Scheme.*—Mentions the assurance given by the Dewan of the State that there should be no misapprehension about this scheme. Excepting the power house which may have to be shifted to some other site, everything has been well done.

*Periyar Dispute.*—States that now that the two arbitrators on behalf of the Madras and Travancore Governments have differed in their awards the question may have to be settled by an umpire.

**SAFETY-VALVE FOR NILE FLOODS : DESERT VALLEY MAY BECOME A LAKE : EGYPTIAN GOVERNMENT CONSULTS BRITISH ENGINEER : ESNA BARRAGE ALSO TO BE STRENGTHENED.**—February 13, 1937.

“ A scheme to form a huge natural reservoir in the desert 80 miles south west of Cairo to act as a safety-valve for the flood waters of the Nile in the event of a superflood is being studied by the Egyptian Government.” Sir Murdoch MacDonald, the British Engineer, has been asked by the Government to draw up a report on the practicability of the scheme. A somewhat similar project was carried out 3,700 years back.

**FLOOD PREVENTION.**—February 13, 1937.

Editorial notes on the need of more flood prevention measures for India  
Examples of U. S. A. and Egypt are quoted.

**AGRICULTURE IN INDIA AND ITS IMPROVEMENT : WHAT GOVERNMENT HAVE DONE : IMPLEMENTING RECOMMENDATIONS OF ROYAL COMMISSION.**—February 14, 1937.

Notes on the statement detailing the action taken by the Government of India on the recommendations of the Royal Commission on Agriculture. Mention is made of the Central Bureau of Irrigation as one of the steps taken to implement the recommendations.

**HOW TO INCREASE PRODUCTION SO AS TO OUTSTRIP CONSUMPTION : PUNJAB GOVERNOR INDICATES WAYS IN WHICH ENGINEERS CAN HELP : 1937 SESSION OF PUNJAB ENGINEERING CONGRESS OPENED.**—February 19, 1937.

Importance of irrigation in increasing production is emphasized.  
Lines of development in respect of electricity and irrigation and opening of communications was dealt with.

**INCREASE IN PUNJAB PRODUCTS : DEVELOPMENT LINES : HOW ENGINEERS CAN SOLVE PROBLEM.**—February 19, 1937.

Same as above.

**ROAD PROBLEMS : U. P. GOVERNOR'S ADVICE : PREPARATIONS BEING SPEEDED UP.**—February 24, 1937.

Opening speech of His Excellency the Governor of U. P. at the Third Indian Roads Congress.

**CURRENT TOPICS : IRRIGATION IN INDIA.**—February 24, 1937.

Speech of H. E. the Governor of the Punjab at the prize giving ceremony of the Rasul Engineering School. Value of irrigation to a country three-fourths of whose population is agricultural is emphasized.

**THE FLOOD MENACE : HOW MAN CONTRIBUTES TO EROSION DANGER.**—February 24, 1937.

Jacks.

An article on the flood menace. Describes how soil erosion is responsible for floods. The main causes given are the destruction of the natural vegetation that everywhere affords the soil adequate protection against the continuous eroding action of water and wind, and the overstocking of pasture land. The remedy lies in the proper conservation of soil.

**MORE THAN MILLION PEOPLE DIE OF MALARIA IN INDIA EVERY YEAR : ANTI-MOSQUITO CAMPAIGN : LT.-COL. G. COVELL'S BROADCAST TALK.**—February 27, 1937.

Among other measures for the destruction of mosquito larvæ is mentioned the need of proper drainage.

**RECLAMATION OF VILLAGE WASTE FOR MEETING FODDER REQUIREMENTS. DANGER OF DENUDING FORESTS : NEED FOR SCIENTIFIC CONTROL.**—March 3, 1937.

Discussion of the problem of improving the fodder supply at a recent meeting of Forest Officers at the Animal Husbandry Wing Conference at Madras. Instances of marked improvement in fodder production following the enforcement of control and closure to grazing were quoted.

**BETTER GRAZING FACILITIES.**—March 4, 1937.

Editorial notes on the press note of the Commissioner for Rural Reconstruction, Punjab, regarding the possibility of utilizing waste land for the production of fodder.

**VICEROY TO SEE U.P. PROJECTS : NEW BRIDGE : INSPECTION OF STATE TUBE-WELL SCHEME.**—March 8, 1937.

The projects to be visited include the Ganges Grid Tube Well Scheme and the Hindan River Bridge. Main features of these two projects are given. The rates charged for water on the Tube Well Scheme are also given.

**VICEROY VISITS U. P. VILLAGES : IRRIGATION PROJECTS INSPECTED.**—March 9, 1937.

**HIGHWAY BRIDGE OF TIMBER.**—March, 9, 1937.

"A treated timber highway bridge is now on show at the Lucknow Exhibition. The bridge was made at the Forest Research Institute, Dehra Dun." The bridge is designed for a live load of 10 tons plus 25% impact and a crowd load of 80 lbs. per square foot before and behind the live load. The span between bridge abutments is 50 feet. The width of the roadway is 16 feet. No piece of timber is longer than 25 feet. The bridge was tested under a steam roller weighing 12½ tons and in addition about 100

men were stationed. The approximate cost of the bridge superstructure is Rs. 2,000. A photograph of the bridge is also given.

**ECONOMIC UPLIFT OF RURAL AREAS : USE OF ELECTRICITY :**

V. CEROW'S VISIT TO U. P. VILLAGES.—March 9, 1937.

Rates charged on the Tube Well Scheme are also mentioned.

**-SIR JOHN RUSSELL IN BIHAR: VISITS SEVERAL INSTITUTES :**

RESEARCH IN IMPROVED AGRICULTURAL METHODS.—

March 10, 1937.

**FLOODS AND FORESTS.—March 10, 1937.**

It is stated that destruction of forests is the real cause of floods.

**HUMAN NUTRITION RESEARCH : WHAT IS BEING DONE AT PRESENT.—March 10, 1937.**

**INDIAN EXPERT ON ALKALINE SOILS TO LECTURE IN ENGLAND.—March 11, 1937.**

Dr. N. R. Dhar, Head of the Chemistry Department of the Allahabad University and an authority on the reclamation of alkaline soils through molasses and press mud is leaving for Europe where he has been invited to deliver a series of lectures explaining his researches.

**MADRAS IRRIGATION PROBLEMS : LOWER BHAVANI PROJECT.—March 13, 1937.**

The Lower Bhavani Irrigation Project, which has been designed to irrigate 207,000 acres and of which the estimated cost is two crores of rupees, is likely to undergo some changes. In the original project it was provided that one third of the area to be irrigated should be watered during the night, but the people are not willing to do this because of the fear from reptiles and wild animals. This has raised the question whether water for night irrigation could be stored separately during night and delivered during day time. Another point to be decided before the scheme is started is the problem of manure. It has been recommended that half the area under the project should grow money crops and the other half cereals, which should be interspersed with manure crops to overcome the manure difficulty.

**FOOD PROBLEM IN SIND : PROF. N.R. MALKANI'S COMPLAINT :**

CHANGING EMPHASIS ON CULTIVATION : DIRECTOR OF INFORMATION'S REPLY.—March 14, 1937.

A press note issued by the Director of Information, Sind, in reply to Prof. N.R. Malkani's talk regarding the Sukkur Barrage. The questions answered are that the Barrage is presenting Sind with a food problem by changing the emphasis of cultivation in two directions, that commercial crops like cotton are given encouragement, that lands are sold on the condition that certain portions will grow on'y cotton, that water supply is being curtailed for food crops and that acreage under cotton has increased from 3½

lakhs to 8 lakhs of acres, and  $5\frac{1}{2}$  lakh acres are under long stapled cotton in demand by Lan ashire.

**EXCISE ON SUGARCANE : HOW IT WILL AFFECT LOCAL IRRIGATION REVENUE : BOMBAY OPINION.**—March 17, 1937.

**TOWARDS A NEW ARCHITECTURE : THE RIGHT USAGE OF REINFORCED CONCRETE.**—March 19, 1937.

Hardy.

A general article.

**IMPROVED SIND COMMUNICATIONS : NEW ROAD SCHEME OPENING UP BARRAGE AREA.**—March 22, 1937.

Notes on the annual report of the Indian Roads and Transport Development Association, Ltd., Sind Branch, for the year 1936. A brief mention is made of the working of the Lloyd Barrage.

**THE NIRA VALLEY PROJECT.**—March 23, 1937.

A press note on the history and development of the Nira Valley Project, Bombay. Includes four photographs, (1) Automatic weir in action at the Lloyd Dam, (2) the lowest sluices in the dam, (3) a view of upstream face looking north, and (4) upstream view at Venturi Meter in mile No. 1 of Nira Right Bank Canal.

The press note is the first of the series of notes to be published regarding recent important irrigation works in India so as to give due publicity to India's achievements in irrigation engineering.

M. T. GIBLING, *Secretary,*  
*Central Board of Irrigation.*

**GOVERNMENT OF INDIA  
CENTRAL BOARD OF IRRIGATION**

**QUARTERLY BULLETIN No. 6.**

**APRIL TO JUNE 1937.**

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**SIMLA,  
15th July, 1937.**

# RESEARCH COMMITTEE ANNUAL MEETING, 1937.



*Front Row.* Mr. G. A. M. Brown, Mr. F. F. Haigh, Mr. C. C. Inglis, Mr. Gerald Lacey, Mr. M. R. Richardson, Mr. G. M. Ross, Mr. M. T. Gibling, Mr. A. R. B. Edgcombe,  
 (N.-W. F. P.) (Punjab.) (Bombay.) (I. P.) Vice-President (U. P.) (Secretary.) (U. P.)  
*Middle Row.* Mr. U. S. N. Mahida, Mr. W. J. Benson, Mr. D. N. Sen Gupta, Dr. N. K. Bose, R. B. Ajudhia Nath Khosla, Dr. E. McKenzie-Taylor,  
 (Bombay.) (Punjab.) (Bengal.) (Punjab.) (Punjab.) (Punjab.)  
*Back Row.* Mr. H. S. Kehal, Mr. J. K. Malhotra, Mr. H. R. Dogra, Mr. A. M. R. Montagu Mr. W. N. McLeod,  
 (Sind.) (Punjab.) (Madras.) (Punjab.)

Office of the Secretary,  
Central Board of Irrigation,  
Simla, H. O.

## **QUARTERLY BULLETIN No. 6.**

APRIL TO JUNE 1937.

### **The Board.**

Rai Bahadur Bawa Natha Singh, Chief Engineer, Punjab, has retired from service from the first week of July and Mr. F. A. Farquharson, M.C., has been appointed in his place.

Mr. F. A. Betterton, Chief Engineer, Bihar, has proceeded on leave preparatory to retirement with effect from 18th May 1937, and Mr. G. F. Hall, C.I.E., M.C., is officiating until Mr. J. G. Powell returns from leave on the 16th of October next.

Mr. G. M. Ross, C.I.E., Chief Engineer, N.-W. F. P., and President of the Board, is proceeding on short leave in July and Mr. A. Oram will officiate for him.

The next annual meeting of the Board will be held in Delhi from 30th October to 4th November.

A meeting of the Executive Committee of the Board was held in Simla on the 24th of June, with Mr. G. M. Ross in the chair. The other two members of the Committee (Mr. Richardson, Vice-President, and Mr. Bedford, Member) were also present.

### **Research Committee.**

The 7th Annual Meeting of the Research Committee of the Board was held in Simla from 21st to 24th June, under the chairmanship of Mr. G. M. Ross, President of the Board. The following officers attended :—

Mr. G. M. Ross, C.I.E., North-West Frontier Province. (President.)	} Executive Committee.
Mr. M. R. Richardson, C.I.E., United Provinces. (Vice-President.)	
Mr. J. D. H. Bedford, Punjab. (Member.)	
Mr. Gerald Lacey, United Provinces.	
Mr. A. R. B. Edgecombe, United Provinces.	
Dr. E. McKenzie-Taylor, M.B.E., Punjab.	
Mr. W. N. McLeod, Punjab.	
Mr. F. F. Haigh, Punjab.	
Mr. A. M. R. Montagu, Punjab.	



Rai Bahadur A. N. Khosla, Punjab.

Dr. N. K. Bose, Punjab.

Mr. J. K. Malhotra, Punjab.

Mr. W. J. Benson, Punjab.

Mr. C. C. Inglis, C.I.E., Bombay.

Mr. U. S. N. Mahida, Bombay.

Mr. H. S. Kahai, Sind.

Mr. H. R. Dogra, Madras.

Mr. G. A. M. Brown, O.B.E., North-West Frontier Province.

Mr. D. N. Sen Gupta, Bengal.

Mr. F. Anderson, C.S.I., C.I.E., Chief Engineer, Bahawalpur State, formerly Chief Engineer, U. P., and President of the Board for 1935-36, was present by invitation.

Dr. W. Burns, Officiating Agricultural Expert, Imperial Council of Agricultural Research, was also present during some of the discussions, by invitation.

The President, Mr. G. M. Ross, delivered the following speech at the opening of the meeting on the 21st June.

“GENTLEMEN,

It gives me great pleasure to have the privilege of presiding at this seventh annual meeting of the Research Committee of the Central Board of Irrigation. During the four years that I have been connected with the Board, I have learnt the immense value of the work being performed by this organization, and particularly by its Research Committee. This annual meeting affords a splendid opportunity for Irrigation Engineers from various parts of this country, who are particularly interested in research, to discuss both formally and informally the many problems which beset irrigation engineers, not only in India, but in other irrigating countries of the world. By constructive criticism of the various experiments in progress in those Provinces which have Research Stations, and discussion of other problems of common interest, we are afforded the best possible means of applying the combined knowledge and experience available in the country, to those problems which are so important to the many millions engaged in cultivation aided by irrigation. You are aware that India has a much greater area under irrigation than any other country in the world, and in fact, it is equal to the total area irrigated by the next five leading countries, including America. There is no need therefore for me to impress upon you the importance of this meeting, and the necessity for careful deliberation over the many problems before us. As the nucleus of irrigation research, in a country where irrigation has been practised over many ages, and has extended to such gigantic proportions, this Committee enjoys a world-wide reputation, and I trust that our business will be conducted with this in view. I am pleased that such a large number

of officers have been able to attend this meeting, thereby creating a new record, which is proof positive that the value of this meeting is realized more than ever by Provincial Governments, and it is hoped that this interest will continue to grow. I extend a special welcome to those of you who are attending this meeting for the first time, and hope that you will return to your Provinces with knowledge which will be of benefit to your Governments, and the cultivators in your Province alike."

The following is a note on some of the experiments and other investigations undertaken during the year in the various Provinces conducting research, and some of the Committee's conclusions. Details of experiments are given in the Research Officers' Reports presented to the Committee (copies available in the office of the Central Board of Irrigation).

Provincial Research Officers' Reports, which were discussed, contained evidence of many useful experiments of far reaching importance having been undertaken.

In connection with land deterioration and reclamation, experiments in the Punjab Irrigation Research Institute show that much greater importance must be attached to atmospheric humidity as a cause of salt movement than was previously considered necessary. It has been shown that soils containing sodium salts can absorb a large amount of water from a humid atmosphere, and that this water is evaporated during the day under certain conditions with consequent salt movement. It appears that greater importance must be attached to the salts present in the soil profile than to those present in solution in the sub-soil water.

The Punjab alluvium consists of a soil crust of varying thickness over sand, and experiments indicate that waterlogging can only take place in which the soil crust is so thin that water can be raised from the water table in sand to the soil surface by capillary or other forces in sufficient quantities to lead to almost complete soil saturation.

The importance of a soil survey of the proposed alignments of new canals has been further substantiated by investigations carried out in connection with seepage from canals. If during the digging of a canal the soil crust is likely to be penetrated, then the seepage from the canal in that length will be excessive. Steps should be taken to change the alignment, if possible, in order to avoid such lengths, or to treat them by some means (*e.g.*, lining) in order to prevent excessive seepage.

In connection with construction and maintenance of kachha roads, methods have been devised for determining the effect of various treatments on the mechanical properties of soils.

Investigations on the design of weirs on porous foundations show that when there are two lines of sheet piling under a floor each of them is most effective in reducing the pressure when it is placed at the end of the floor. When, however, either of them is moved towards the centre of the floor its efficiency decreases. It is also found that the influence of one sheet pile is not perceptible on the other until they approach each other to within a distance which is about twice the length of either of them. Many of the works of this nature are provided with three lines of sheet piling, and it is found that if the intermediate sheet pile is about the same length as the end sheet piles or is shorter, it should be placed as near the centre as possible if it is to exert its maximum effect in reducing pressure. If the intermediate pile is longer than either of the end piles it will produce its minimum effect in reducing pressure if placed midway between the end piles. To increase its effect it should be moved towards either end.

It was stated that an investigation has been in progress to determine whether it is possible to devise a method for detecting defects and cavities under weirs on sand foundations. The safety of this type of structure depends very largely upon the stability of the material underlying the weir. If cavities are formed and are not detected, the safety of the weir is at stake. The principle employed in the method under investigation is that wireless waves are partially reflected from any surface of discontinuity and when coming from different distances would reach an aerial in different phases. The composite reflected wave can be analysed by means of a cathode-ray oscillograph operated with a high-frequency time-base, and from the nature of the reflection it is possible to discover and locate any defects.

Water of various silt contents and various temperatures was used in order to ascertain the effect, if any, of silt and temperature on discharge measurements, and it was found that within limits of experimental error, variation in the temperature and the silt content of the water does not produce any appreciable difference in the discharge measured by a rectangular weir and a velocity meter.

The discharges of the Ravi river above Madhopur and the rain-fall data for Dalhousie were studied separately and jointly to discover the effect, if any, during the last 35 years, of the alleged denudation of the foot hills on the changes in summer and winter supplies. It was concluded that the floods were neither heavier nor more frequent in recent years, and that though there was no apparent tendency for the winter supplies to decrease, they needed to be carefully watched.

In order to study the effect of the rise of water-table and other factors on the various aspects of village life, histories of individual fields are being collected, together with other data, for 14 villages in the Sheikhpura District.

Experiments were carried out on models with the object of determining the form of protection to be adopted for the reduction of scour

downstream of the Ferozepore, Islam and Balloki weirs. Experiments were also carried out in connection with the remodelling of Merala weir and the design of Trimmu weir for the Haveli Project. Designs for the construction of Jatli level crossing of the Upper Jhelum Canal were also examined. Models of several canal falls were studied in connection with downstream scour and side erosion.

It is concluded from experiments on the reclamation of Thur land that if the proper rotation of crops is adopted on land reclaimed from Thur there will be little decline in yield when the crops are grown on a zamindari water supply. The crop rotation that has been found most suited for reclaimed land is :—Berseem or Sanji, Sugar cane, Sugar cane (ratoon), Wheat and Cotton.

Aerial photography has been adopted to supplement ground surveys of areas affected by Thur as it has been difficult in the past to obtain a reliable survey with which the present Thur conditions could be compared. By means of aerial photographs it has been possible to distinguish Thur land which has never been broken, from land in which Thur has developed since irrigation commenced. The method will be of great value in recording rapidly the original and present conditions of irrigated areas.

During the initial stages of the development of an irrigation scheme a considerable portion of the water supplied is used in permanently increasing the moisture content of the soil profile, and when this maximum saturation of the soil has been reached it should be possible to reduce the water allowance without affecting the yield of crops or the intensity of cultivation. If the same water allowance is maintained, then the intensity of cultivation should increase.

Experiments carried out by the Research Officer, United Provinces, indicate that the application of sodium carbonate to canal beds can be relied upon to reduce losses by 35 per cent, for soils which contain more than .098 per cent. of exchangeable calcium. The staunching effect is found to extend to a depth of one foot, and after six months from the time of application the staunching is still effective. Three methods of application have been tried and the cost varies from 0.5-6 to 0.14-10 per hundred square feet. Experiments are under investigation to ascertain the effect of treating canal beds with molasses in order to prevent seepage. The method has not been found very successful so far, but it is still under investigation.

Several types of devices for excluding excessive silt from canals are under investigation, and results are awaited, but it has been found that King's vanes have been found a successful device.

Experiments with a model to determine the most economical size of fall for the Karonnadi show that with a plain horizontal downstream floor a fall with a crest 200 feet in length with a depth of 16 feet is the most economical design.

The question of the use of coal tar for protecting steel work on hydraulic structures is under investigation.

The designs of flumed bridges and syphons were investigated with a view to cheapening the cost of construction.

The results of several interesting experiments on models at the Karachi Research Station were reported. Scour downstream of regulators and falls is a problem which calls for investigation by models, and as a result of the experiments, devices have been introduced which not only prevent further scour below the structures but also cause silting up of existing scour holes. In remodelling a regulator to be fitted with vertical screw gates in place of vertical "needles", a model was prepared to determine the effect of the change, and to suggest necessary alterations to control the high velocity jet if formed. The model proved useful in indicating the detailed alterations necessary to provide a successful structure. The old Bhagar Inundation Canal which takes off from the Indus River about 70 miles below Kotri has a number of bends in its total length of 90 miles. One such bend of 9 miles length was proposed to be eliminated by excavating a cut 3,000 feet long to a point in the canal where there is a drop of 19 feet from the bed of the cut to the scoured bed of the canal, and a regulator was proposed in the new cut. Due to its nearness to the sea, the regulator would come under the influence of tides, and it was decided to model the proposed design to ascertain what the downstream action would be and whether it would carry the required discharge without undue afflux, which would necessitate providing higher banks.

Another very interesting model experiment was carried out to ascertain the steps to be taken to provide an off-taking channel with the benefits of across regulator on the parent channel some distance above it. A divide wall was constructed in continuation of one of the piers of the regulator, connecting up with the downstream abutment of the off-taking head, and the gate in that bay of the cross regulator will be operated so as to discharge the correct quantity into the off-taking channel. The question of silt draw was also investigated.

Experiments are also in hand with the treatment of canal beds with sodium carbonate to reduce seepage losses.

Important investigations in connection with sub-soil drainage have been carried out in Sind, the results of which will be of considerable value in the Board's examination of the drainage problem, in connection with which the Research Committee framed a questionnaire. A study of the data available from sub-soil water investigations shows that the spring level in Sind is more or less steady.

In the areas investigated it has been found that sub-soil water which had a high salt content before the opening of the Lloyd Barrage Canals, has become diluted to some extent since the introduction of perennial irrigation. The continuation of these investigations are important where the water table is high or rising, in order that steps may be

taken, if found necessary, to prevent rise of the water table close enough to ground surface to permit of damaging land by salts drawn up by capillarity and other forces.

A number of interesting experiments were carried out during 1936-37 at the Hydrodynamic Research Station at Khadakvasla near Poona. This Station is being financed by the Government of India during the present financial year pending decision as to whether an all-India research station for Irrigation is necessary, and if so, where it should be located, and the nature of work to be carried out. Bombay Government maintained this Station up to the end of last financial year but with the separation of Sind they were unable to continue to finance it, and it was proposed that it should be continued as a Central station financed by either the Central Government or by contributions from Provincial Governments and other bodies such as the Railway Board.

The work carried out last year included several river training problems, and others connected with storage reservoirs, canal falls, etc.,

In 1920 a causeway was constructed across the Sina River 5 miles from Ahmednagar on the Mannad Road, and since then the river has been scouring out the right bank to such an extent that it was feared that the causeway would be outflanked. Two masonry groynes and a flank wall were constructed in 1929 with the object of diverting the river to its original bed, but without success. A model of the site was constructed and investigations on it showed that the groynes only deflected the low velocity bed water and accentuated the erosive action of the high velocity top water. It was found that the difficulty of scouring could best be overcome by making a cut through the projecting nose on the left bank of the river just above the causeway.

A new high level causeway was built across the Mula River at Rapuri in the Ahmednagar District in 1922, and the existing ferry was shifted about 500 feet upstream, but it was found that the river currents made use of the ferry unsafe. A groyne was constructed in 1929 to divert the high velocity current from the landing stage, but it did not materially improve matters. After testing out several proposals on a model, it was found that the solution lay in the construction of 5 groynes pointing upstream.

From a working model of the Bhimgoda Weir across the Ganges at Hardwar in the United Provinces it was ascertained that the best method of protecting the Weir downstream of the undersluices was to provide a "baffle" and a "deflector". As it was feared that any such device would be damaged by boulders which are washed down the river, or that they would be trapped, pebbles were used in the model to represent boulders in the river, and it was found that they were washed over the baffle, and presented no difficulty.

The reservoir at Bhandardara (Lake Arthur Hill) at the source of the Pravara River is provided with a waste weir to carry off surplus

water in order to prevent the dam from being over-topped. By improving this waste weir it will be possible to discharge a full flood when the necessity arises, but at the same time, the level of it can be raised, thus enabling a large quantity of water to be stored in the reservoir. Owing to the large area of the lake at full supply level, which is the spilling level of the waste weir, a few inches extra in depth will provide a very large quantity of extra water which can be utilized in expanding the area under irrigation. By means of models the correct discharging capacity of the spillway as it exists has been ascertained, and experiments are now in hand to enable a suitable profile for the weir to be designed.

Experiments with a large scale model of the Hardinge Bridge over the Ganges are still in progress, and a similar problem, namely, training the river above the Sarda Barrage at Banbassa, United Provinces, is also undergoing investigation. One branch of the river above the Barrage tends to swing across the face of the Barrage and is liable to create serious conditions.

Experiments on guide banks for bridge protection and falling aprons for embankments are still in progress for the Railway Board. From experiments on canal falls some important conclusions have been reached.

A number of important experiments were carried out on soil and irrigation research by the Irrigation Research Division at Poona and Baramati comprising the study of typical soil profiles, the physico-chemical changes caused by irrigation and high sub-soil water levels, and the reclamation of soil tilth of damaged lands after drainage. It has been found that irrigation damages some types of soil whereas it is beneficial to others, the depth of the sub-soil water being an important factor, thus showing the necessity for a careful soil, and sub-soil water table survey in areas to be brought under irrigation.

Experiments with Gypsum, Sulphur and Lime for improvement of soil tilth showed that in a field of sugar cane, Gypsum is of considerable value, whereas Sulphur and Lime are of little benefit.

For damaged soil, several varieties of cane were grown for comparison of yield,—CO 212 and CO 285 being the most successful.

*Dhaincha* was found most suitable as a green manure, and *Nilva* proved to be the best fodder crop. *Dhaincha* reduces sodium and alkalinity in the soil more effectively than Sann Hemp but the latter nitrifies the soil more rapidly than the former.

Sewage effluent from the Poona Drainage Improvement Scheme has been used since 1929 by passing it down canal distributaries for use with irrigation water in certain areas suitable for the purpose. As the quantity of effluent has increased more than ten times in the past

five years there is difficulty now in disposing of it in the limited area available. In order to ascertain the maximum quantity that can be utilized in this manner, experiments have been carried out to determine the maximum dose applicable to sugarcane, and the varieties of cane most suitable for this treatment.

In connection with the discussion on the seepage of water from canals and the means to prevent it, it was decided that the method of applying sodium carbonate to the bed of a canal containing a quantity of calcium clay, is a cheap and effective method of rendering the canal bed less pervious. The best method of application appears to be the broadcasting of the dry material on the surface after removing one foot of material from the bed, and then replacing it. The most efficient rate of application of the sodium carbonate is found to be 100 lbs. per 1,000 sq. ft. of surface treated.

The design of canal falls is a subject which has received considerable attention by the Board and its Research Committee for several years, but it has not yet been possible to specify any one type of fall which answers all purposes, and the question of preparing type designs is still under consideration. A number of experiments have been carried out at the Hydrodynamic Research Station at Poona in accordance with the suggestion of the Board, and some interesting results have been obtained. These results were brought to the notice of the Committee by Mr. Inglis, and it was stated that some of the designs had proved successful on models and also on works in Sind. Mr. Inglis' complete report on the subject is not yet ready, but it is hoped that it will be ready in time for examination by the Board at its next meeting at the beginning of November. The Committee is of the opinion that until comprehensive research has placed the principles of design beyond dispute it is inadvisable to record a recommendation in favour of any type design for general application.

During the discussion on the Questionnaire on "Conditions predisposing to harmful soil saturation which may ultimately result in water-logging" it was decided that as the conditions in various Provinces varied to a considerable extent, and prevented the framing of replies to questions to meet all conditions the Provinces should reply to the questions separately, in order that the various conditions prevailing in Provinces may be compared.

In connection with the meandering of rivers, it was stated that rivers appear to meander more in equatorial regions than in the polar regions, and the reason for this phenomenon, if ascertainable, would probably throw some light on this problem which is of considerable concern to all Provinces. It was considered that distinction should be made between meandering and tortuosity. The question of providing cuts in order to shorten tortuous rivers was discussed at length; the advantage of this method is highly problematic. On the Mississippi



and Missouri Rivers in America the problem of flood control has been dealt with in some areas by providing cuts, and in others by constructing levees (embankments).

Prior to discussion of the questionnaire on Land Reclamation there was a short talk on Air Surveying, and photographs were exhibited of areas affected by salt which had been photographed in order to provide an accurate and complete record of the areas so affected. It is proposed to introduce a periodical survey by this means in order to maintain a record of the affected areas and to ascertain whether there is any increase or decrease in the area. Examples of river surveys by aerial photography were also exhibited, and it was seen that they would be of considerable value in river training and harbour problems.

In connection with the design of weirs on permeable foundations it was stated that the publication dealing with this problem, which has now been completely solved, will be issued shortly by the Board. A new subject to be taken up for discussion at next year's meeting is that of silt excluding and ejecting devices for canals.

A group photograph of the officers attending the Research Committee meeting is reproduced in this Bulletin.

### **Board Publications.**

Revised edition of "Glossary" (Pubn. No. 5) is still under preparation, as replies from some officers have not yet been received.

"Design of Weirs on Permeable Foundations" (Pubn. No. 12) is still in the press, but is expected to be issued shortly.

Annual Report (Technical) of the Work of the Board for 1935-36 (Pubn. No. 14) was distributed during the quarter.

The Research Committee passed a resolution recommending that Mr. Gerald Lacey should be placed on special duty to write up his publication on the design of canals in alluvium.

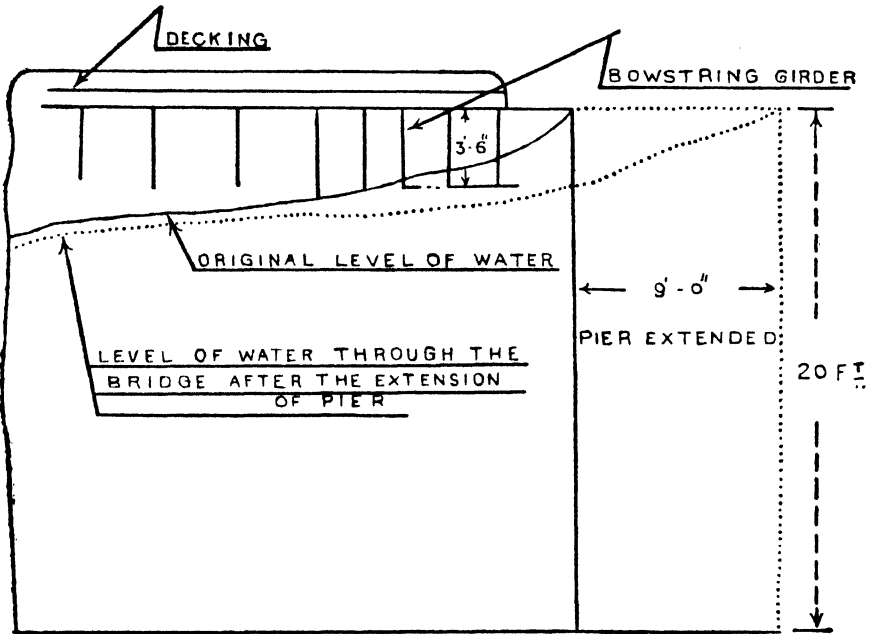
### **Works Section.**

#### **MADRAS.**

#### *Works of a Novel Character constructed at the Mettur Dam.*

Due to the contraction of the waterway at the site of the bridge over the channel from the sluices at Mettur, there was considerable velocity and afflux whenever full supply (28,000 cusecs) was discharged, with the result that the water hit the bow string girders of the bridge. The piers on the upstream side were lengthened by 9 feet and built to a lenticular shape. This alteration shifted the point of afflux sufficiently upstream to ensure that the girders cleared the water. The old piers and the extensions are shown in the diagram below.

2. At the same bridge considerable disturbance due to eddies was observed in the triangular pockets where the sloped revetment met the vertical wall of the bridge abutment. The revetment was removed in a length of 75 feet and replaced by a wall designed to give a smooth stream-line connection between the vertical abutment and the 1:1 revetment. This alteration has had the desired effect; the flow is now smooth.



(NOT TO SCALE)

### **Dadupur Silt Excluder, Western Jumna Canal.**

The Dadupur Silt Excluder was constructed during the early part of 1936 and was opened in June of that year.

Its object is to stop or reduce the progressive silting which is taking place in the Main Line Lower and Main Branch of the Western Jumna Canal. It comprises four tunnels averaging  $7'5'' \times 3'5''$ , taking approximately the lower one-fifth of the water approaching the canal regulator, the canal capacity being 6,400 cusecs.

A unique feature of the design is that water enters the tunnels through an orifice 1' high which is continuous across the bed of the canal. Uniform distribution and loss of head is secured by the use of 36 curved reinforced concrete vanes situated in this opening.

The photographs on the opposite page show the downstream tunnel portals with their gate control, and the canal regulator with the excluder abutment on the left.

### **Information Bureau and Library.**

It is brought to the notice of readers of this Bulletin that it has been arranged to keep the Library of the Central Board of Irrigation at Simla open to 7-30 P.M. on all days except Sundays and other closed holidays, with effect from 12th July, so that it may serve as a reading room for officers who are in Simla during the summer season, on duty or otherwise. Recent periodicals and other literature will be available for perusal.

The following are some of the enquiries dealt with during the quarter under review :—

Staunching of canals with particular reference to the method of applying sodium carbonate.

Lacey theory for the design of canals.

Standard methods for testing materials for earthen dams.

Tube Wells.

Air conditioning of buildings.

Reinforced concrete arch bridges.

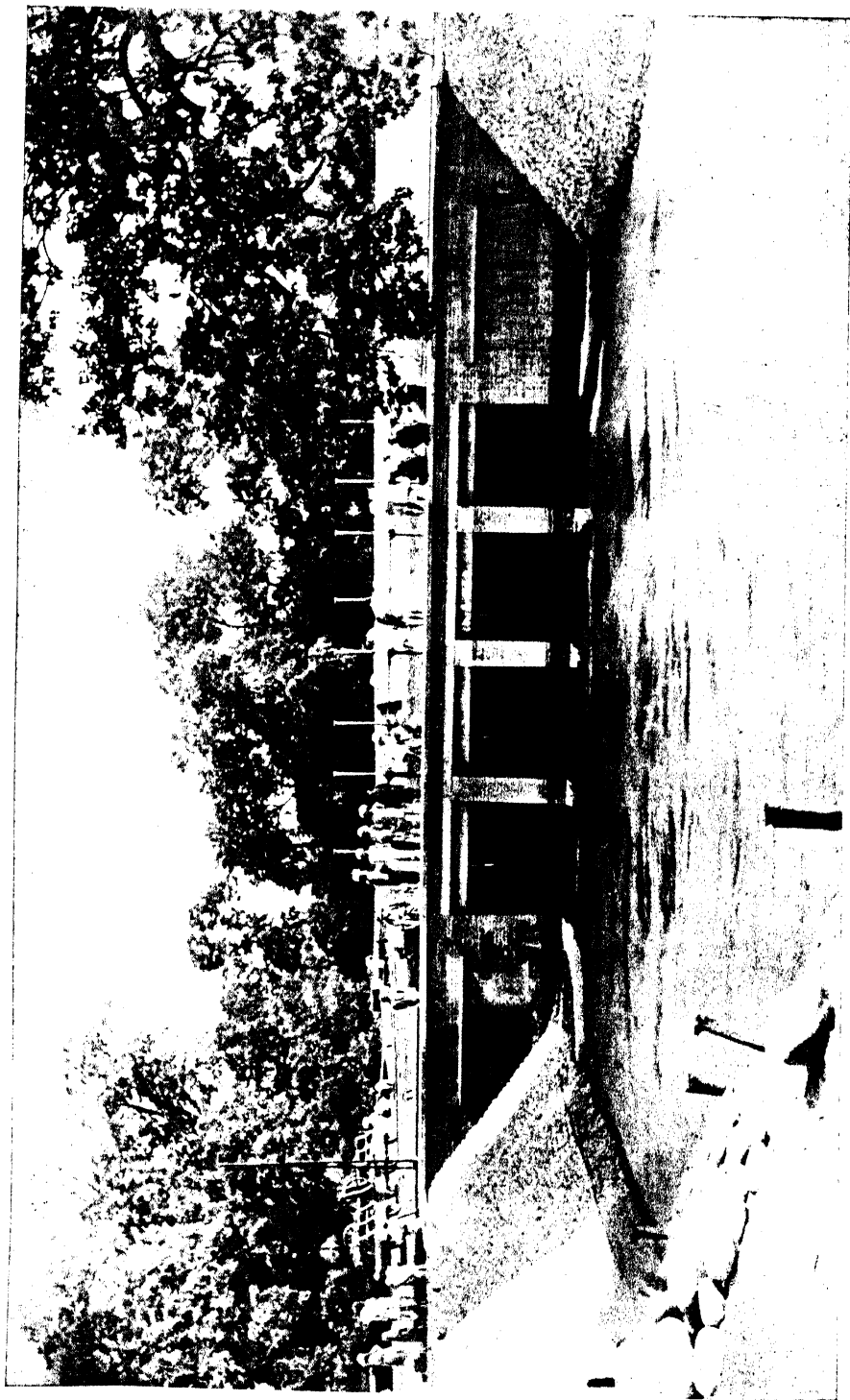
Experiments on canal falls.

Replies to the Questionnaire on "Meandering of Rivers", which was circulated to Members of the Board, Railway Board, and a few others during the last quarter, have been received from some officers. The Questionnaire will be discussed at the next Board meeting.



Canal Regulator with the Excluder Abutment on the left.

DADUPUR SILT EXCLUDER.



The following is the programme for 1937-38 of the Hydrodynamic Research Station (Khadakvasla) near Poona, which is being financed by the Government of India for one year from the 1st of April last :—

The programme is split up into

- I. Specific experiments, and
- II. Basic Research.

#### SPECIFIC EXPERIMENTS.

*Experiments on behalf of the Railway Board in continuation of last year's experiments.*

1. Experiments with the extended 1/500 scale model of the Ganges and the Harding Bridge for investigating the movements of the River. This is a long series which will continue throughout the year.
2. Experiments with (1/2000 scale) small model of the Ganges for determining fundamental laws for reproduction of Rivers in small models.
3. Pier experiments for protection with stone pitching against scour.
4. Guide Bank experiments to show action of falling aprons and best methods of protecting guide banks on this principle.
5. Subsidiary experiments such as effect of clay belts on scour downstream of piers in 1/500 scale model; effect of size and shape of stones on scour round piers.

*Fall Experiments for the Central Board of Irrigation (in continuation of last year's experiments).*

6. Experiments with low falls.
  - (i) standing wave flume meter fall.
  - (ii) plain weir fall.
  - (iii) weir falls with glacis, arrows and control blocks.
  - (iv) weir falls with glacis, baffle, cistern and deflectors.

*Experiments for the U. P. Government.*

7. Training of the River Sarda at Banbassa.
8. Methods of preventing scour and protecting the floor downstream of the Sarda Barrage.
9. Experiments with a model of the Ganges River and Canal Head works at Hardwar.

*Experiments for Sind.*

10. Experiments with a model of the Sukkur Barrage to prevent silting near the right bank upstream of the Barrage.
11. Reduction of scour at bends.

*Experiments for the Baluchistan Government.*

12. Model experiments on waste weir of the Spin Karez Reservoir Project.

*Experiments for the Central Provinces Government.*

13. Uplift pressures in submersible bridges.

*Experiments for the Government of Madras.*

14. Silt exclusion experiments with vanes.

15. Design of baffles and deflectors for an apron downstream of anicuts and regulators.

16. Reducing afflux in the Krishna Right & Left Bank Head Works by bellmouthing upstream, and expansion downstream.

*Experiments for the Central Government.*

17. Training of the River Jumna at Delhi.

*Experiments for the East Indian Railway.*

18. Experiments with piers of Lower Sone Bridge.

*Experiments for the Government of Bombay (Deccan).*

19. Experiments with model of the Godavari Right Bank Head Regulator to reduce scour downstream.

20. Experiments with models of the waste weir of Lake Arthur Hill (Bhandardara), in connection with raising the weir to increase the tank contents.

21. Experiments with a model of the Sina River and causeway on Nagar-Manmad Road.

22. River training experiments of Mula River at Rahuri.

23. Experiments with a model of Aqueduct No. 3 of the Girna Canal to prevent scour downstream.

24. Training the Nala upstream of Aqueduct 6 of the Nira Right Bank Canal to prevent silting.

25. Training the Nala upstream of Aqueduct 12 of the Nira Right Bank Canal to prevent silting.

**BASIC RESEARCH.**

26. Investigation of bed movement of various types of sand, and silt under controlled conditions.

27. Meandering of Rivers.

28. Laboratory experiments to determine factors affecting losses from Canals.

29. Experiments to determine the merits and demerits of various types of spurs.

30. Scale effect of rigid structures and guide banks on model slopes.

31. Weir experiments to ascertain maximum coefficient.

32. Experiments for B. D. V. relationship in expansions.

33. Continuation of experiments to show effect of scale on scour.

34. Experiments with Canal culverts to reduce afflux.

35. Experiments with head regulators to ascertain factors causing loss of head and scale effect of model.

### 36. Experiments with standing wave flume

- (a) to observe the effective head due to velocity of approach with upstream channels of various shapes.
- (b) to find the effect of depth upstream of the hump on coefficient, keeping the width of the upstream channels constant.
- (c) to find the optimum position of the upstream gauge.
- (d) to find the effect of the throat length and sloping glacis downstream on coefficient.

### 37. Venturi flume experiments.

To produce best type designs and calibrate them (continuation of last year's experiments).

38. Experiments with the modified design of the Crump Adjustable Proportional Module to find the minimum modular head.

### MISCELLANEOUS.

The United Provinces have adopted the Lacey theory for the design of channels in alluvium and several channels have been constructed or remodelled in accordance therewith. It is too early at present to say whether those channels have proved satisfactory, but where the theory has been properly applied, there is no case of it having proved unsatisfactory, and the results are promising.

The following extract from the Administration Report of the P. W. D. (Irrigation Branch), Burma for 1935-36, shows the results obtained by widening the Ye-U canal according to the Lacey theory :—

“The Ye-U Canal, which is on the convex side of the river, silts up very rapidly. It was unsilted in 1922 and again in 1927. On each occasion the bed was unsilted to its designed bed width and bed level. In 1936 it was decided to widen the canal to a section conforming with the principles expounded by Lacey of the United Provinces, and to leave the bed silt undisturbed. This was done with gratifying results. The maximum discharge secured at full supply level has been 1692 cusecs, a discharge much in excess of that secured in 1922 and 1927, and at a much smaller amount of expenditure.”

The newspapers report that the Sind P. W. D. have now under investigation a hydro-electric scheme under which it is proposed to generate electricity at the Tando Mastikhan Fall on the Rohri Canal where there is a fall of 8' and a discharge of about 10,600 cusecs. The scheme is estimated to cost 10 lakhs, and will probably supply energy to Sukkur, Rohri and other neighbouring towns, and meet the demands of the new cement factory to be erected at Sukkur. The details of the project will be worked out by the Chief Electrical Engineer in Sind. If the required financial resources are available the scheme will be launched by Government; if not, it will be left to private enterprise.



Proceedings of the 2nd International Congress on Large Dams, which was held in U. S. A. in 1936, will be available for sale very shortly. The Proceedings consist of 5 volumes, Vol. I—General description of the Congress, General Reports, Resolutions and Index, Vol. II—Reports and Discussions on Question No. 3 (Special Cements); Vol. III—Reports and Discussions on Questions Nos. 4 and 5 (No. 4—Design and Water proofing of Shrinkage Contraction and Expansion Joints; No. 5—Study of the Facing of Masonry and Concrete Dams); Vol. IV—Reports and Discussions on Questions Nos. 6 and 7 (No. 6—Geotechnical Studies of Foundation Materials; No. 7—Calculation of the Stability of Earth Dams); and Vol. V—Communications on (1) Experimental methods for insuring the safety of gravity dams, in particular by the study of internal pressure, (2) Study of dams built of precast concrete blocks with special reference to the avoidance of setting stresses in mass concrete, (3) Dams built by depositing stones in running water, and (4) What are the best means of preventing “piping”? Complete sets of the Proceedings will be available for approximately 58 rupees (500 francs) excluding customs duty, transport and other charges, if ordered before 1st August 1937, otherwise 600 francs. Individual volumes are priced separately—Vol. I, 110 fr.; Vol. II, 95 fr.; Vol. III, 120 fr.; Vol. IV, 160 fr.; and Vol. V, 110 fr. There will probably be a rebate of 33 per cent. if the volumes or complete sets are ordered through this office.

The following officers of the Irrigation Departments of the various Provinces received the honours noted against them on the occasion of the Coronation of His Majesty the King Emperor George VI:—

G. M. Ross, Esqr., B.A.I., I.S.E., Chief Engineer and Secretary to Government of N.-W. F. P. in the Public Works Department. (President of the Board for 1936-37).

C. I. E.

Khan Bahadur MAULVI ABDUL AZIZ, I.S.E., Superintending Engineer, P. W. D., Irrigation Branch, U. P.

C. I. E.

H W. ODDIN, TAYLOR, Esqr., O.B.E., A.C.G.I., A.M.I.C.E., I.S.E., Superintending Engineer (Irrigation) and Joint Secretary to the Hon'ble the Agent to the Governor General in Baluchistan in the Public Works Department.

C. B. E.

Captain A. E. GREEN, M.C., A.M.I.C.E., I.S.E., Temporary Superintending Engineer, Bihar.

O. B. E.

Mr. MANMATHA BHUSHAN DATTA, Subordinate Engineering Service, S.D.O., Irrigation Department, Bengal.

M. B. E.

Mr. DHANAPATI MONDAL, Overseer in the  
Irrigation Department, Bengal.

Kaiser-i-Hind  
Medal (3rd Class)

Lala DEVI SINGH, Executive Engineer,  
P. W. D., Irrigation Branch, Punjab.

Rai Bahadur.

Rao Sahib NARAYAN RAMCHANDRA JOSHI,  
Bombay Service of Engineers, Asstt.  
Engineer, Belgaum Division, Bom-  
bay.

Rao Bahadur.

Babu NARENDRA NATH DAS, Offg. Executive  
Engineer, Burdwan Division, Bengal  
Presidency.

Rai Sahib.

Babu JOGENDRA SHANKAR DHAR, Assistant  
Engineer, Irrigation Department,  
Bengal Presidency.

Rai Sahib.

Lala KANWAR SAIN, Executive Engineer,  
P. W. D., Irrigation Branch, Punjab.

Rai Sahib.

BELI RAM MALHOTRA, Esqr., B.Sc., Asstt.  
Engineer, P. W. D., N.-W. F. P.

Rai Sahib.

Lala HARCHANDI LAL, Asstt. Executive  
Engineer, Central P. W. D.

Rai Sahib.

M. R. RY. KRISHNA AYYANGAR SRINIVAS,  
Offg. Assistant Engineer, P. W. D.,  
Madras Presidency.

Rao Sahib.

Preliminary work on the Haveli Project in the Punjab is expected to commence next cold weather. Mr. F. F. Haigh has been appointed Superintending Engineer of the First Haveli Circle, and Rai Bahadur Ajudhia Nath Khosla is to hold charge of the Headworks Division at Trimmu. A special Designs Division has been formed under the control of the Chief Engineer (Construction), and Rai Sahib Lala Kanwar Sain has been appointed to it.

Alternative designs of the proposed Weir at Trimmu are being modelled and tested at the Research Institute in Lahore.

Mr. A. M. R. Montagu, the former Secretary of the Central Board of Irrigation, has been placed on special duty to investigate the possibility of introducing Tube Well irrigation in the Punjab on a large scale.

The Punjab Waterlogging Board decided at a recent meeting that aerial photography is a suitable means of making and recording an accurate survey of salt affected land, and recommended that surveys should be made periodically by this method, in order to ascertain the areas, if any, in which the trouble is spreading.

The Thal Canal Project in the Punjab is undergoing further investigation, with a view to presenting the scheme to the Legislature for consideration, in the near future.

Preliminary work has been undertaken in connection with the Teje-wala Headworks, Western Jumna Canal, Punjab, where it is proposed to remodel the gates of the undersluices on the right bank during the coming winter.

There is a proposal to provide a line of sheet piles downstream of Islam Weir, Sutlej Valley Project, Punjab.

### Literature.

The following literature was received in the library during the quarter under review :—

*Readers are reminded that they are at liberty to borrow any of the literature in the Board's Library, in accordance with the rules published in Bulletin No. 3, and to submit enquiries on any matter dealing with irrigation and allied subjects.*

### PERIODICALS.

#### CIVIL ENGINEERING AND PUBLIC WORKS REVIEW.

VOL. XXXII.

No. 369—March 1937.

#### THE ZILLERBACH DAM.

This dam impounds water for the supply of the town of Wernigerode. It is of concrete gravity type and the principal dimensions are : length of crest 570 ft. ; height 154 ft. ; width at base 105 ft. There are expansion joints at 40 ft. intervals, and a waterproofing layer 4 ft. thick on the upstream face. The expansion joints cut straight through the dam, and are sealed by copper sheets situated 2·6 ft. from the upstream face. The copper sheets are ·08 in. thick and 2·8 ft. wide. At the centre of the copper plate there is a 4 in. fold to allow for movement between the blocks, and these folds are embedded in asphalt. The concrete surface at the expansion joints was given a 12 in. coating of bitumen.

#### WIDENING RICHMOND BRIDGE.

Describes the method of chemical consolidation to be used in the foundations. The existing piers are supported on timber rafts resting on the gravel bed of the river and enclosed by timber piles. The first stage in the extension of the piers will consist of driving to the London clay a steel sheet pile cofferdam around each pier. Excavation will then be carried out down to the level of the lower surface of the timber raft. A series of grouting holes will then be drilled 2 ft. apart, from the bottom level of the raft to the London clay, and chemical consolidation will be carried out by the "Joosten" process. By this means, a wall of consolidated

gravel 4 ft. thick will be formed round the periphery of the pier extending from the underside of the timber raft to the London clay.

THE LATERAL FORCES ON STANCHIONS IN SINGLE  
STORY BUILDINGS.

Voce.

This is the fourth of a series of articles on the subject and deals with the calculation of bending moments due to lateral forces on stanchions when they are all main stanchions, the internal stanchions have large spacings and bracing is not provided.

COAST PROTECTION WORKS IN LINCOLNSHIRE.

Haynes.

The tides of the river Humber have been encroaching upon the Lincolnshire shore to the west of the outfall of the river Ancholme into the Humber. Hundreds of acres of fertile land have been washed away. Flood banks were erected by landowners for protection of the shore but these were found to be ineffective. A road which runs parallel to the foreshore and near it became endangered in 1935, and the Catchment Board concerned advanced for consideration a scheme of stabilizing the shore line with brushwood mattresses and stone. The first part of the scheme is intended to protect the underwater slopes of the bank. A series of eight strong points are being constructed extending to the river bed. The footings of these strong points consist of groups of brushwood mattresses 2 ft. in thickness extending from low water spring tide level to the river bed, sunk and weighted down with stone. These are finally covered with about half a ton of stone per square yard. Special slag pitched buttresses will then be laid on the slope above the low water mark up to the existing stone pitching of the road embankment. The base line and sides of the buttresses will be held by sheet steel piling. The procedure of making the mattresses and sinking them in position has been described in some detail.

NEW BRIDGE IN LATVIA.

Describes a recently completed Bridge in Latvia. It consists of 3 main spans of 82.5 m each and is designed for railway and highway traffic. The girders of the main spans are of the Warren type. An interesting feature in the design of the main spans is the elimination of secondary stresses by predistortion of the steelwork. In the fabrication of the steelwork, the lengths of the members were increased or decreased by amounts equal to the increments or reductions in their lengths developed under full load conditions.

## BUILDING SCIENCE ABSTRACTS.

## CEMENT SETTING TEMPERATURES.

Santarella.

The Author presents a report on tests carried out on neat cements, mortars, and concretes with a view to determining the relationship between the heat of setting, the type of cement used, and the mechanical properties of the hardened products. The cements were tested both when fresh and after storage. One general conclusion from the investigation is that for any given cement the lower the temperature of setting, the lower the strength. Moist curing is the most satisfactory method as regards strength development.

## PENETRATION OF MOISTURE INTO MASONRY WALLS.

National Bureau of Standards, T. N. B. 1936  
(234).

Describes tests of the rate of penetration of moisture through masonry walls. Water was applied by means of a spray at the top of the wall to simulate rainfall. Measurements were made of the time for dampness to appear on the unexposed surface. The results of the tests are discussed.

*No. 370—April 1937.*

## NOTES OF THE MONTH.

## THE INSTITUTION OF ENGINEERS (INDIA).

Comments on the annual report of the Institution of Engineers (India) for the year ended August 31, 1936. Membership increased by 79. The Institution continued to act as the Indian Committee of the British Standards Institution. His Excellency the Viceroy's prize was awarded to Mr. G. Bransby Williams for his paper on the design of masonry gravity dams.

## FOREIGN NOTES.

In V. D. I. Zeitschrift 81, 29, G. Musssnug discusses the action of the various substances which are added to Portland cement clinker to control the time of setting. Ordinary Portland cement is very rapid setting unless a delaying agent is present. This is usually some form of calcium sulphate.

## MODERN SUSPENSION BRIDGES.

McConnel.

For bridges of spans in excess of 1,000 ft., the suspension type is more frequently used than any other type. This type of structure is not confined however to large spans and for spans not exceeding 100 ft., foot bridges and pipe line structures can be built of this type economically, while for light highway bridges it can be advantageously used.

for spans as short as 150 ft. Outstanding examples are confined to America, and a large number have also been built in France and the French Colonies. This type has however been undeservedly neglected by British engineers on the ground of its lack of rigidity, which may be a factor to be considered in railway work but does not affect highway work. Some advantages of this type of bridge are described. Features of the older types are discussed. In the earliest suspension bridges, chains of wrought iron links were used for suspension. Improvement in wire ropes during recent years has resulted in the universal adoption of the wire rope for suspension. A general description of some modern bridges of this type in America, and the Continent of Europe is given, and American and Continental practices are compared.

**THE LATERAL FORCES ON STANCHIONS IN SINGLE  
STORY BUILDINGS.**

Voce.

Continuation of articles in previous issues. A number of examples are worked out to illustrate the methods used to calculate bending moment and deflexions, etc.

**BUILDING SCIENCE ABSTRACTS.**

**THE DETERMINATION OF COMPRESSIVE STRENGTH  
AND HEAT EVOLVED BY CONCRETE IN THE INTERIOR  
OF LARGE MASSES BY MEANS OF THE  
THERMO-ELECTRICAL CALORIMETER.**

Honigsmann.

Paper presented at the Second Congress on Large Dams. A new highly sensitive calorimeter without heat capacity for the exact determination of the heat given out by the concrete, and its uses for the determination of compressive strength in the interior of large concrete masses are described. The heat evolved per unit of time during hardening depends on the proportion of the mix, the water added, the atmospheric temperature prevailing, and the hardening pressure. The compressive strength is also primarily dependent on the same factors and therefore there is a close connexion between heat evolved and compressive strength.

**SOIL EROSION.**

Roscamp.

In this article attention is drawn to the serious losses caused by erosion, and some measures to combat this evil are indicated. From experiments made it has been found that for a given number of gallons per acre of rainfall, bare plots lose 56,222 lbs. of soil per acre, cotton plots lose 37,745 lbs. per acre, corn plots 13,152 lbs. per acre and Bermuda grass plots only 262 lbs. per acre. Results of tests show

that provision of vegetable cover is the most effective method of dealing with the problem of erosion. The three general principles to be observed are given as (1) the encouragement of ground cover (2) the leveling of sites and (3) the construction of barriers to stay the velocity of water run-off. If erosion is left uncontrolled in the higher reaches of a river watershed, the usefulness of large dams and hydro-electric works in the lower reaches becomes questionable.

*No. 371--May 1937.*

THE INTERNATIONAL CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Editorial review of the International Congress held in London from April 19 to April 24. Over 200 papers by leading authorities of 20 countries were presented before the Congress. More than two thirds of these dealt with metals or inorganic materials. All the papers indicate the rapid rate at which research work is advancing the knowledge of materials. In no field perhaps is more investigation being carried on than into the properties of concrete, plain and reinforced. 43 papers were presented on this subject. The subjects dealt with in the papers include: Strengths of concretes and cements under various conditions of temperature; the accelerated ageing of a sample by the passage of an alternating current through it; and the vibration of concrete. The accelerated ageing of samples may open up new possibilities in carrying out a test equivalent to a 28 day test in about 24 hours after preparation of the sample.

NOTES OF THE MONTH.

FENLAND FLOOD ALLEVIATION.

Dr. Schoenfeld, Director General of Inland Waterways of Netherlands, was invited to make an examination of the flood control methods in use in the Fenlands. The cause of recent floods in the Fenlands may be ascribed to heavy rainfall, high tides, and a north-east wind. The high sea levels caused by spring tides and north east winds result in a considerable backing up of the rivers along the lower reaches, causing floods. Dr. Schoenfeld suggests the construction of a suitable outfall sluice at a point near the mouth of the river. This would avoid overtopping the banks at high tide, but adequate storage for maximum run-off over the catchment would be necessary. A second alternative suggested is the construction of a barrage across the Wash. The area of the Wash cut off from the sea by the barrage would serve as an immense flood storage

reservoir which could be discharged through sluices at suitable states of the tide. The work however presents serious difficulties besides being a very costly undertaking. The maximum depth of water in which work would have to be done is about 100 ft. and the tidal range is 22 ft.

#### FOREIGN NOTES.

##### LARGE SCALE VIBRATION OF CONCRETE.

In *Le Genie Civil* 158, 110, W, the use of a mechanical vibrator specially constructed for the slopes of the inlet canal of the Champaubert Reservoir in the forest of Der in France is described. The canal is over 3 miles in length and has a bed width of 13 ft. and depth of 6 ft. The bed and slopes will be concreted with 6 inch depth of concrete. The concrete was vibrated with a specially designed apparatus which is described.

##### THE NEW DOG IN A DOUBLET BRIDGE.

Harper.  
Hill.

Describes the detailed design of a new reinforced concrete bridge at *Dog in a Doublet*. The bridge consists of three spans of reinforced concrete flat slab construction. The two side spans are 60 ft. while the centre span is 100 ft. The centre span is composed of two 30 ft. cantilevers supporting a central suspended slab of 2 ft. 6 inches thickness. The cantilevers are 5 ft. 6 in. thick at the supports and are cast monolithic with the end spans of 60 ft. The joint between the cantilever and suspended slab is of the halved type and is  $\frac{1}{2}$  in. thick throughout. Compound plates of  $\frac{1}{4}$  inch steel and  $\frac{1}{4}$  in. phosphor bronze are fixed to both the suspended span and the cantilever and set  $\frac{1}{4}$  inch into the concrete and fixed by means of rag bolts. The piers are founded on 14 in. by 14 in. reinforced concrete piles 26 in number. The end supports consist of 3 ft. wide by 2 ft. deep rectangular pile caps resting on five 14 in. by 14 in. reinforced concrete piles. Details of calculations for the design are given.

##### FOUNTAIN WORK AT LEICESTER: STRENGTHENING A BRIDGE ABUTMENT.

An interesting and unusual method of strengthening a bridge abutment is described in this article. The bridge in question is a single span wrought iron arch bridge with brick abutments out over a canal. The span is 74 ft. Cracks of a serious nature occurred on one abutment. An examination of the cracks indicated that the abutment had sheared along a horizontal plane below the sandstone bearing blocks. There was no indication of settlement having



taken place, and the movement was entirely horizontal. The essential features of the reconstruction scheme were: the strengthening of the abutment brickwork by grouting and the insertion of dowels; and construction of three pressure piles behind the springing of each arch rib at the east abutment, the tops of the piles being incorporated in a reinforced concrete slab resting on the top of the abutment brickwork. The arrangements and details of work are described at length with several illustrations.

#### THE LATERAL FORCES ON STANCHIONS IN SINGLE STORY BUILDINGS.

Voce.

Continued from previous issue. In the present article, the author deals with the computation of wind and other loads on stanchions in a complicated structure.

#### IMPROVEMENTS TO THE RIVER REA, BIRMINGHAM.

Describes some features of the work of improving the channel of the river Rea near Birmingham. The work consists of deepening the masonry invert of the river by 4 ft. in a length of 1170 yards. This lowering of the river bed necessitated underpinning of one road bridge, a viaduct, a culvert underneath a railway goods-yard, and an aqueduct. The methods adopted for underpinning are described in brief.

#### BUILDING SCIENCE ABSTRACTS.

Waterproofing bridges and other structures: *Wasserund Wegebau-Zeitschrift*, 1936, 34(11). The use of a synthetic product resembling rubber, in the form of fabric and of adhèsive dressing on some bridges in Germany is described. Waterproofing of a bridge by means of sheets of a special copper alloy is also described.

### CONCRETE AND CONSTRUCTIONAL ENGINEERING. VOL. XXXII.

No. 3—March 1937.

#### THE MODULAR RATIO—III.

Hajnal-Kónyi.

The third and final article on the new method of design of reinforced concrete omitting 'm' the modular ratio. The latest method of design developed by Prof. Saliger of Vienna is described. The correctness of the method has been checked by tests in England and America. The results obtained from the tests are shown to compare favourably with those obtained by Dr. Saliger's method.

**THE IMPACT TEST FOR PILES.**

Pimm.

The impact test for piles as usually defined and applied possesses some very grave defects. These are discussed and a more scientific form of the test is suggested.

No. 4—April 1937.

**EXPERIMENTS ON THE VIBRATION OF CONCRETE.**

Review of the interim report issued by the Joint Committee of the Institutions of Civil and Structural Engineers on the vibration of concrete. The report deals with results of tests made on an experimental vibrating table which allows a vibration frequency of between 500 and 8,000 vibrations per minute. Conclusions arrived at on the basis of the tests are given. (See Bulletin No. 6.)

**THE CONSTRUCTION OF LARGE DAMS AND PIPES.**

Abstract from a lecture delivered by M. A. Coyne, the well known French engineer at a joint meeting of the *Societe Ingenieurs Civils de France* and the Institution of Civil Engineers. The lecture dealt with the design and construction of dams and pressure pipes, and strengthening of existing dams. The Mareges dam construction and the strengthening of the Grands Cheurfas dam in Algeria are described in detail. (See pages 46 and 47 of Bulletin No. 5.)

**UNIFORM FLOW IN PIPES.**Hogan.  
Gibbs.

Continued from previous issue. In this article the resistance to flow developed by bends, elbows and tees in pipes is dealt with.

**EXPERIMENTAL WORK ON ROADS.**

Notes from the Report of experimental work on Highways Committee for 1935-36, are presented in this article. The experimental work covered a wide field and included tests on various types of transverse joints, shrinkage tests, concrete proportions, movement of road slabs jointless construction of concrete slabs and tests of various types of surface treatment. The results of the tests are discussed in brief.

**REDISTRIBUTION OF MOMENTS IN CONTINUOUS BEAMS.**

Results of tests undertaken to investigate the redistribution of moments in continuous beams are published in the Report of the Building Research Board for 1935. The results are discussed in this article.

No. 5—May 1937.

#### IMPROVEMENT OF THE RIVER NENE.

A comprehensive scheme of river improvement is in progress under the Nene Catchment Board. The object of the scheme is to improve the drainage of the whole area and also to provide improved facilities for navigation. The scheme includes dredging of several reaches of the river Nene, and reconstruction of locks, weirs, etc. Details of some of the works are given, with illustrations.

#### THE MODULAR RATIO : A NEW METHOD OF DESIGN

OMITTING *m*.

Discussions on the above paper by Mr. Manning, Mr. Mason and Mr. Adler are given. Dr. Saliger who is the originator of the new method of design further elaborates his principles and has shown with the aid of typical examples that the new method is simpler than the standard method. Mr. Manning criticizes the new method and sees no cogent reason for adopting it. Mr. Mason discusses the limitations of the new method and its advantages.

#### TESTING MATERIALS.

Synopses of the following papers presented at the International Association for Testing Materials held in London in April 1937, are given.

1. Relation between the tensile and compressive strengths of mortars and concrete, by R. Feret.
2. Porosity and permeability of concrete, by R. Feret.
3. Durability of aggregates, by A. T. Goldbeck.
4. Materials for the thermal insulation of buildings, by E. Griffiths.

#### THE SOIL-LINE METHOD OF RAFT DESIGN.—VII.

**Baker.**

Continued from previous issue. Examples of calculations for a typical slab and beam raft are given.

THE ENGINEER.

VOL. CLXIII.

No. 4236—March 19, 1937.

#### MISCELLANEA.

##### PROTECTION OF METALS.

In the course of a paper on "Metallic Corrosion" read before the Midland Metallurgical Societies, Dr. Evans described the difference in the protective effect of red lead and iron

oxide paints. As a result of a large number of experiments with sheets of steel covered with a coat of linseed oil and the two pigments, it was concluded that red lead was more effective in preventing attack of steel by corrosive agents.

#### WELD BRITTLINESS AT LOW TEMPERATURES.

A series of tests to ascertain if welds in steel have a tendency to brittleness at low temperatures has been carried out by Prof. Henry. The conclusion drawn was that welds in mild steel are in no sense brittle and are but slightly inferior to mild steel at both normal and low temperatures.

*No. 4237—March 26, 1937.*

#### NEW WATER SCHEME FOR DURBAN.

A new bill for this scheme is under consideration before the Parliament of the Union of South Africa. It is proposed to dam the Umgeni river at a point 30 miles from Durban in what is known as "the valley of a thousand hills". The reservoir will impound 5,000 million gallons. There will be a diversion weir at the head of the reservoir. The aqueduct will be 31.06 miles long comprising a pipe line and four tunnels. The water supply will be gravitational throughout.

#### MISCELLANEA.

##### GREATER VOLGA SCHEME.

This is a new scheme which has recently been taken up in the U. S. S. R. It includes large hydroelectric power stations on the Volga and the Kama rivers and the deepening of these rivers for the purpose of linking up the southern and northern seas and irrigating the dry steppes of the Volga. The hydro-electric power stations will have an aggregate capacity of 10,000,000 kilowatts.

#### CANADIAN ENGINEERING NEWS.

##### VANCOUVER BRIDGE.

Contract for building the bridge over the Vancouver harbour has been awarded. The structure will be the largest suspension bridge in the British Empire and will be 209 ft. above high-water. The cost of the bridge is estimated at 6,000,000 dollars.

*No. 4238—April 2, 1937.*

#### NEW TATA IRON AND STEEL PLANT.

The Tata Iron and Steel Company of India has announced an important programme of extensions to its plant at Jamshedpur. With these extensions the Tata Company and

its associated concerns will be able to supply four-fifths of the aggregate Indian demands for rails, sleepers, sections, plates, sheets, tubes, wire rods, and wire.

#### ARCH DEFLECTIONS AND TEMPERATURE STRESSES IN CURVED DAMS.

Houk.

Temperature stresses in horizontal elements of arch dams must be computed in working out adequate designs. This article presents a method of computing the temperature stresses. Equations have been developed by the usual methods of arch analysis for arch movements at the crown due to thrust, shear, bending moment and temperatures. By manipulating these equations an expression has been obtained which shows that for given values of modulus of elasticity, co-efficient of thermal expansion of concrete, and temperature change, the temperature stresses are proportional to the ratio of the radius to the thickness of the arch and the angle from the crown to the abutment.

#### MISCELLANEA.

##### RUST-PROOF PAINT.

A new product for protecting metal known as "Rust-eeter" has been marketed. It is applied direct to the rusted surface and reacts with the rust in such a way as to transform it into an essential part of the protective coating. It is a form of paint with a basis of chlorinated rubber. It is suitable for exposure to corrosive vapours, rain, salt water, and other climatic conditions. It can be sprayed as well as applied with a brush. It sets to the touch in 20 minutes.

##### WOOD PRESERVATION.

A new method of wood preservation has been patented in Germany. The material used is a silicic acid ester of phenols. It reacts on the moisture contained in the wood and produces silicic acid hydrates and free phenols. The toxic action of phenol renders the wood immune against decay, and fungi.

##### AIR AND WATER.

##### AERIAL PHOTOGRAPHY IN CANADA.

Aerial photography was introduced in Canada in 1922 and since then by this means 4,81,000 sq. miles of country have been mapped in difficult and unsettled regions.

# PROTECTION OF TIMBER PILES IN SEA WATER.

At the Permanent International Association of Navigation Congresses an interesting method of protecting timber piling in sea water was described. In this method coatings of portland cement mixed with arsenious oxide, sand, and water are applied to the timber. A special form of cement gun was devised to apply the mixture. Driving of the piles caused no deterioration of the coating. The coating is applied over wire mesh reinforcement nailed on to the pile. The method can also be employed for the protection of concrete structures against the corrosive action of sea water.

# ENGINEERING NOTES FROM CHINA.

The Jubilee Dam at Shing Mun was declared finished by the Governor of the Colony at the end of January. It is the highest dam in the British Empire and incorporates 2,000,000 tons of rock, sand and cement. It took five years to complete. A large labour force of 2,500 was employed and housed at the site. (See pages 25 and 28 of Bulletin Nos. 4 and 5 respectively.)

*No. 4239—April 9, 1937.*

# VAAL RIVER DEVELOPMENT SCHEME.

Describes a scheme under construction in South Africa, for the irrigation of the Hartz River Valley. The scheme, which was briefly outlined in the Engineer December 11, 1936 (See pages 22-23 of Bulletin No. 5) is here described in detail. The works consist of a concrete gravity dam across the river Vaal with an earthen embankment on one flank. The principal dimensions of the dam are:

Length along crest	1,700 ft.
Height above river bed	135 ft.
Upstream face	Vertical.
Downstream face	Batter 0·7 to 1
Quantity of concrete in the dam	220,000 cu. yds.

The earthen embankment is 4,500 ft. long, with an upstream slope of 3 to 1 and downstream slope  $2\frac{1}{2}$  to 1. The dam will impound 800,000 acre ft. but with relatively minor additions to the crest provision has been made for a future impounding capacity of 1,800,000 acre ft. One main feature of the construction works was the dewatering of the river section and foundation excavations. These operations are described in detail. Concrete is placed by means of cable ways and dump buckets. In the construction of the earthen embankment, power shovels will load

materials from the borrow pits to tip wagons, trains of which will be taken to the bank, drawn by light locomotives. The material will be rolled by rollers drawn by tractors.

The diversion weir which is about 350 miles downstream will divert the water to the head of a canal designed to carry 1,000 cusecs. The main canals consist of 100 miles of concrete lined waterways. The weir is 2,380 ft. long and 37 ft. high above the river bed. Several photographs showing the various stages of construction are included.

#### ARCH DEFLECTIONS AND TEMPERATURE STRESSES IN CURVED DAMS.

Houk.

Continued from previous issue. This article indicates a method of computing arch deflexions at crown cantilevers of curved concrete dams due to water load and temperature effects. The deflexions are given by two formulae due to Professor Cain. The author however suggests that for important dams over 100 ft. high designs developed on the basis of deflection adjustment at crown section should be checked by a detailed trial load adjustment at several additional cantilever sections before starting construction.

#### MISCELLANEA.

Water Power Resources of Canada. The annual review of the water power resources of Canada has been issued recently. The available water power is 20,347,400 H.P. under conditions of ordinary flow.

Anodising Aluminium Alloys. A note in *Iron Age* gives particulars of a process whereby aluminium alloys can be protected against corrosive attack in the salty air of sea coast locations. The alloy is used as an anode in an electrolytic bath consisting of a solution of chromic acid. An oxide coating is formed on the anode which effectively resists corrosive action.

No. 4240—April 16, 1937.

#### FORT PECK DAM.

This is a large earthen dam now under construction across the river Missouri in the north-east of Montana State in the U. S. A. The dam is designed to store the flood season run-off which will be utilized to maintain a depth of 8 ft. to 9 ft. in the lower reaches of the river for navigation all the year round. The dam is 1,875 miles upstream from the mouth of the river and is so located that the river water impounded at the dam has very little silt in

suspension. The river below the dam site is a typical alluvial stream with an unstable channel and carries a heavy silt load. The dam will create a reservoir about 185 miles long with a maximum width of 17 miles and will impound 19,500,000 acre ft. of water. The maximum height will be 287 ft. America is famous for its monumental concrete dams and it may be asked why such a gigantic dam is being constructed of earth. The answer lies in the geological conditions of the site. The geological section consists of a 1,000 ft. thick stratum of shale underlying 150 ft. depth of alluvium. The character and thickness of this overburden rendered it impracticable to excavate down to the shale and construct a concrete dam from that depth. It was therefore decided to build an earthen dam and to tie it to the basic shale by means of a cut off wall of inter-locking sheet piles driven a little way through the sale. A number of photographs illustrating the construction are included. (See also pages 52, 54 and 55 of Quarterly Bulletin No. 3.).

#### WIDENING OF RICHMOND BRIDGE.

Richmond Bridge across the Thames near London is to be widened to suit modern traffic conditions. The piers will be enlarged by enclosing them with a line of sheet steel piling and concreting the foundations in this enclosed area. The extensions of the arches will be built of Portland stone faced with the original masonry. The stone arches of the old bridge are believed to be of insufficient strength to stand up to the modern loading requirements. It has been found however that if the loads are distributed instead of concentrated, they would be able to withstand stresses with a margin of safety. In order to ensure a distribution of the load, an ingenious plan will be adopted. The bearing surface over the crown of the arch will be a heavily reinforced concrete raft, supported upon a thick sheet of cork to distribute the load over the arch below. Each raft will be some 40 ft. long and will be constructed in two parts with an articulated division along the centre line of the bridge.

*No. 4241—April 23, 1937.*

#### FORT PECK DAM NO. II.

Describes construction operations, and works. The dam is being built in two sections as the tunnels or the diversion of the river are not yet ready and the river has an unobstructed flow at the centre of the dam site. Four dredgers are employed in forming the embankment which is being built up of the dredged material. Four diversion tunnels



will divert the river water. The tunnels will be concrete lined and 24 ft. 8 in. in diameter. The combined capacity of the four tunnels will be 84,000 second feet. The spillway taps the prospective basin at a point  $3\frac{1}{2}$  miles eastward of the dam where nature has facilitated the creation of an outlet by providing a narrow dry valley. The final outlet of the spillway will be a channel reaching the river at a point 8 miles downstream of the dam. The spillway will have 16 stoney gates, each 40 ft. long by 25 ft. high. For a distance of a mile downstream from the spillway, the spillway channel will be lined with concrete on the floor and the side slopes. The piers and abutments of the spillway structure will rest on a solid slab of concrete 80 ft. wide and  $12\frac{1}{2}$  ft. thick. The slab is supported by 520 concrete cylinders 5 ft. to 6 ft. in diameter rising from shafts sunk 35 ft. to 40 ft. in the shale stratum.

#### MODERN HYDRAULIC TURBINES.

Watson.

Describes the essential features of some typical modern turbines. Spiral cased turbines with vertical and horizontal shafts, and pelton wheels with horizontal and vertical shafts are described with illustrations. The 17,000 H.P. Pelton machine installed at Shanan, Punjab, India, the 15,000 H.P. sets of Pelton wheels of the Indian Tata power Company, and the Francis turbines of the Sivasamudram scheme in Mysore are described. Factors affecting the choice of different types of machine are discussed.

#### INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

The International Congress of the International Association for testing materials was held in London in April 1937. The papers received number 250, of which the following three papers are reprinted.

1. The Phenomenon of Creep Recovery.
2. The Mechanism of the Creep of metals.
3. Effect of temperature on the properties of steels.

*No. 4242—April 30, 1937.*

#### MODERN HYDRAULIC TURBINES.

Watson.

Continued from previous issue. Describes the Francis turbine and its development. Formerly, Francis turbines were used for medium heads below 500 ft. and Pelton wheels were used for higher heads. In recent years, the Francis turbine has gradually cut into the field of Pelton wheels for higher heads. Several improvements to the Francis

turbine were effected with the increasing use of this type. Some modern installations are described including those at Niagara, and the Boulder Dam. The respective advantages of the vertical and horizontal shaft machines are discussed.

#### MISCELLANEA.

##### CORROSION RESISTANCE OF METALS.

Various methods of surface treatment of steel to increase corrosion resistance were recently discussed in a paper. Application of surface washes of phosphoric acid in alcohol solution to de-scaled surfaces is economically possible now as a result of researches.

##### THE COST OF COMPRESSING AIR.

In the course of a recent paper Major David has given a table showing the costs of compressing air by electric and steam driven compressors.

##### INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

A few of the papers presented at the Congress of the International Association for testing materials recently held in London are given. The following papers are included:—

1. Corrosion as influenced by increased temperature.
2. Deformation and fracture of metals as revealed by X-rays.

*No. 4243—May 7, 1937.*

##### THE VOLGA CANAL.

The Moscow Volga canal has been completed, and the capital has now been linked up with the Baltic Sea, the White Sea, and the Caspian Sea. The Moscow Volga canal is 80 miles long and transverses seven large lakes. The largest of the lakes has an area of 123 sq. miles. The canal has eleven locks, twelve large dams and eight hydro-electric stations.

##### MODERN HYDRAULIC TURBINES.

Continued from previous issue. Turbines for low falls are dealt with in this article. Propeller type turbines are the most suitable for low falls. This may be of the fixed or adjustable blade type. The Kaplan turbine is described in detail, and some important turbine installations are described with illustrations.

##### AIR CONDITIONING AT THE NEW ALHAMBRA THEATRE.

The new Alhambra theatre being constructed in London will be equipped with air conditioning plant. The plant is designed to give a constant dry bulb temperature inside

the building of 68°F when the outside shade temperature varies between 80°F and 30°F. The theatre will accommodate 2,300 persons. Each occupant will be supplied with 1,200 c. ft. of fresh air per hour. The rotary water vapour refrigerating plant is illustrated and described. The complete plant will deliver  $1\frac{1}{2}$  tons per minute of correctly conditioned air to the theatre.

**PRESENT TENDENCIES IN WATER TURBINE  
MACHINERY.**

Fulton.

This article presents a discussion on the present day trends in the design of Francis turbines and Pelton water wheels.

*No. 4244—May 14, 1937.*

**SINKING DEEP CAISSONS BY THE SAND-ISLAND  
METHOD.**

This is a recently developed method of sinking caissons that has been used with success for the deep water piers of the New Orleans Bridge across the Mississippi river near Crescent City, U. S. A. The method consists of enclosing the area where the caisson is to be sunk by a steel sheet cofferdam and filling the enclosure with sand to an elevation above high water. A sand island is thus formed on which the cutting edge of the caisson is set precisely. The sand island is of a larger diameter than the diameter of the caisson. The caisson is sunk through the sand into the bed of the river. Some of the advantages claimed for the method are that the sand island being carried up to an elevation above high water level, flood waters cannot interfere with the work; the caisson walls can be built of reinforced concrete throughout, unweakened by the timber used in the conventional caisson; the concrete in the caisson walls is placed dry and in a place which is easily accessible. Some details of this method as used in the New Orleans bridge are given in this article.

**MODERN HYDRAULIC TURBINES.**

Watson.

Continued from previous issue. Some types of thrust bearings are described in this article.

**PRESENT TENDENCIES IN WATER TURBINE  
MACHINERY.**

Fulton.

Continued from previous issue. Describes a number of new improvements in the component parts being tried on modern Francis turbines and Pelton wheels.

## SOUTH AFRICAN ENGINEERING NOTES.

## VAAL-HARTZ IRRIGATION SCHEME.

The scheme has been half completed, and the major difficulties tackled and overcome. The distribution weir is 360 miles downstream of the main dam known as Vaal bank dam. (See page 22 of Bulletin No. 5.) This weir is a hollow wall of cement concrete 25 ft. high across the river. Solid rock had to be excavated to a depth of 25 to 32 ft. to carry the water from the Vaal river valley to the Hartz river valley. The length of this rock cutting is 4 miles.

*No. 4245—May 21, 1937.*

Not yet received.

*No. 4246—May 28 1937.*

THE WORLD POWER CONFERENCE TRANS-CONTINENTAL  
TOUR, No. I.

Describes the tour arranged in connexion with the World Power Conference in September 1936. One of the works visited which is described in this article is the Grand Coulee Dam. This dam is still under construction and will be 4,300 ft. long, 550 ft. high, 500 ft. thick at the base and 30 ft. thick at the top. It will be of concrete and of the straight gravity type. It will create an artificial lake 385 ft. deep at the dam extending 151 miles with an average width of 18 mile.

*No. 4247—June 4, 1937.*

THE WORLD POWER CONFERENCE TRANS-CONTINENTAL  
TOUR, No. II.

Continued from previous issue. In this article are described the Skagit River Power Development scheme, and the Bonneville Dam Project. The former includes the Diablo Dam completed in 1930. It is a concrete dam of the arched gravity type 1,180 ft. long, 389 ft. high, and 146 ft. thick at the base. The reservoir provides 90,000 acre ft. of storage. The powerhouse is equipped with two 95,000 H. P.

The Bonneville Dam is of concrete gravity section with reinforced concrete piers which will support eighteen vertical lift gates. The dam proper is 1,090 ft. long and 170 ft. high, and 200 ft. wide at the base. The dam is under construction.

*No. 4248—June 11, 1937.*

**THE WORLD POWER CONFERENCE TRANS-CONTINENTAL  
TOUR, No. III.**

Continued from previous issues. The Big Creek—San Joaquin Power Scheme is described. It supplies 532,172 H.P. The Shave Lake reservoir formed by building a concrete gravity dam 2,200 ft. long and 190 ft. high, acts as a water conservation and flood control reservoir. The Tennessee Valley Scheme is also described. A few of the dams included in the scheme, namely, the Wilson Dam, the Wheeler Dam and the Norris Dam are described. All these are concrete gravity dams.

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*No. 3723—May 21, 1937.*

**FLOOD CONTROL ON THE MIAMI RIVER OF OHIO**

**Bennett.**

The flood control works of the Miami River Valley of South Western Ohio were completed fifteen years ago. The works consist mainly of five large retarding reservoirs located at Key points along the valley. The river channel was also improved and flanked by levees through the nine cities along the river. The sole purpose of the works is for flood control and no permanent storage is permitted. The dams are earthen structures of the hydraulic fill type pierced by concrete conduit outlets whose action is automatic. The works have checked and controlled flood flow many times since their completion but the record floods of January 1937 gave them their maximum test. A hydrograph showing the uncontrolled and actual discharges obtained at Dayton shows the effectiveness of the retarding reservoir in controlling the floods of January 1937.

**JOURNAL OF THE INSTITUTION OF CIVIL ENGINEERS.**

*No. 3—January 1936.*

**THE TREATMENT OF MUD-RUNS IN BOLIVIA.**

**Morum.**

A mud-run which may occur in any of the mountain ravines is composed of a flowing mass of detritus and water with the consistency of porridge. When the geological formation is comparatively new, the material forming the sides of the ravine slips down and is carried away by the

torrential streams which occur during and after every rainfall. On the Bolivia Railway the mud-runs were a source of great trouble because they blocked up the openings provided for the flow of water and over-flowed the track. This paper describes the methods adopted to control the mud-runs which include counter erosion cross walls across the valley and earthen dams. The principles of design of these works are set forth, and some actual works in existence are described.

**FLOW BETWEEN PIERS : THE CASE OF SMALL  
LOSS OF HEAD.**

Ionides.

A formula is given for determining the flow between piers. The formula contains a co-efficient which depends upon the ratio of the waterway between piers to the natural waterway in the channel and has been called the "obstruction ratio". In practical problems of design the formula may be used to determine width of waterway between piers. The conditions under which the formula may be applied are stated.

**ENGINEERING RESEARCH.**

The research recently carried out and in hand include investigations on :—

- Reinforced concrete piles.
- Temperature effects in concrete.
- Workability and grading of aggregates.
- Vibrations in buildings.
- Deterioration of structures in sea water.
- Foundations.

*No. 7—June 1936.*

**CORROSION OF IRON AND STEEL.**

Hadfield.

Main.

This paper describes some modern researches on corrosion of iron and steel including the work of the sea action committee of the Institution of Civil Engineers. The data obtained in the course of the research has been analysed statistically and results are discussed. Some practical exposure trials to examine the behaviour of various steels subjected to marine corrosion were also made. The results of these trials are discussed in detail.

**THE RATIONAL DESIGN OF STEEL BUILDING  
FRAMES.**

Baker.

In 1929 the Department of Scientific and Industrial Research appointed a committee to investigate the question of

revision of regulations governing the design of steel work for buildings in view of the improved quality of steel manufactured in recent years. The committee was in existence for six years and considered more than one hundred and fifty reports from investigators. The committee reviewed present methods and regulations for design of steel structures including bridges, and investigated the application of modern theories to such design. The committee also made recommendations on the basis of their investigations on better and more efficient designs. The present paper gives an outline of the committee's work which will be of great value in following the full report of the committee. The experimental frame used in the investigations is described with some of the actual experiments conducted. Tests on existing buildings are also described, and results reviewed. The general behaviour of frames and stanchions, effect of floors, and behaviour of connections are discussed. The evolution of the new method of design is explained, and its application is shown by giving detailed calculations for a six storey building frame.

**THE REDISTRIBUTION OF MOMENTS IN REINFORCED-  
CONCRETE BEAMS AND FRAMES.**

Glanville.  
Thomas.

This paper is in two parts. Part I describes tests carried out to determine the redistribution of moments that may occur in reinforced concrete beams, both at working loads and near failure, as a result of inelastic deformation of either the concrete or the steel. The term "redistribution of bending moments" is used to describe a departure from the distribution that would occur in a purely elastic frame work.

Part II describes investigations made with the object of examining the necessity for designing columns to resist bending as well as direct stress. Results of the investigations and tests are discussed at length and conclusions arrived at are stated.

**ENGINEERING RESEARCH.**

It has been decided to appoint a sub-committee of the Institution to investigate the problem of flow in open channels and pipes. The constitution of the Committee is given. A questionnaire is being circulated to various water authorities, seeking information on flow in pipes, etc.

The sub-committee on earth pressures has in hand the study of the shear strength of clay soils. A note summarizing the more recent work done is given. The note describes the method of measuring the shear resistance of clay

soils under simple conditions of stress and with minimum restraint. This has been done with a torsional shear apparatus which is described. Compression tests were also made with a special apparatus. The results of the tests are discussed.

*No. 1—November 1936.*

#### ENGINEERS AND EMPIRE DEVELOPMENT :

##### PRESIDENTIAL ADDRESS OF SIR ALEXANDER GIBB.

He speaks of the contribution of the engineers towards the development of the Empire and to civilization. Some of the important works carried out by engineers on Canals, Roads, Bridges, Railways, Ships, Ports, Irrigation and water supply are mentioned.

#### THE RESTORATION OF THE BREACH IN THE RIGHT GUIDE BANK OF THE HARDINGE BRIDGE.

Harvey.

The Hardinge Bridge over the Lower Ganges at Sara consists of 15 main spans of 350 ft. with 3 land spans of 75 ft. at each end. The piers are built on wells sunk 150 ft. below low water level. The steining of the wells consists of concrete blocks with a mass concrete core. The maximum discharge of the river on which the design of the waterway was based is 2,500,000 cusecs. The course of the river in this tract is unstable, and extensive training works were necessary to ensure its flowing through the bridge. The bridge was completed in 1915. In 1925 the river attacked the left bank near Sara and the action increased till 1931 when a portion of the revetment near Sara collapsed. The obstruction caused by the sunken work directed towards the right bank a strong current which threatened a serious embayment 2 miles above the bridge. The matter was referred to Messrs. Rendel, Palmer and Tritton, consulting engineers, and on their advice, the right guide bank was constructed in June 1933. In September 1933, a breach occurred in this guide bank due to abnormal rise of the river and the safety of the bridge was endangered. The services of Sir Robert Gales were requisitioned and he arrived in India in December 1933 and drew up a scheme of protection which was carried through before the next monsoon season. This paper gives a detailed description of the breach and the immediate steps taken to control the situation, discusses the causes of the breach and describes Sir Robert Gales' scheme of restoration. The actual construction of works comprising the scheme, the arrangements made in connexion with the construction operations and the experience



gained in carrying out the works are described in detail.  
(See also page 120 of Bulletin No. 4.).

#### NEWRY SHIP-CANAL IMPROVEMENT SCHEME.

Ferguson.

This paper describes the scheme of improvement of the Newry Ship-Canal which did not admit vessels large enough for the economical carriage of goods under modern conditions. The scheme comprised widening and deeping of the canal, bank protection works, new lock gates, and new wharf. The works are described in detail, and an analysis of costs is given at the end.

#### SIMPLE EXPERIMENTAL SOLUTIONS OF CERTAIN STRUCTURAL DESIGN PROBLEMS.

Pippard.  
Sparkes.

A new method for determining experimentally the resultant reaction at different points in a loaded structure is described in this article. A model of the structure is cut out of sheet xylonite and is fastened down on a sheet of smooth paper in a manner appropriate to the support-conditions of the actual structures. The positions of a number of points on the model are marked on the paper and then a known displacement is given to the point at which the reaction is applied. The new positions of the original points are marked on the paper. The displacements of these points provide points for the influence line. The method is illustrated by working out a number of examples such as beams, segmental arches, spandrel braced arches, etc.

#### THE ACTIVE AND PASSIVE PRESSURES OF SEA-SAND BEHIND A VERTICAL WALL.

Fordham.

This is an abstract from a paper describing experimental research carried out in order to find the actual distribution of pressure behind a vertical wall, and the general law of variation of pressure with depth of sand.

### ENGINEERING RESEARCH.

#### REPORT OF THE FIRST INTERNATIONAL CONFER- ENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING.

Cooling.

This is the report of the representative of the Building Research Station of England, who attended the conference held in June 1936. He gives his impressions of the conference and makes comments on each of the fifteen sections into which the Proceedings of the conference are divided. In a general review the author points out that the importance of soil studies has been recognized in nearly every

country in the world, and more active co-operation is necessary between the practising engineer and soil worker. Hydraulic research at the City and Guilds College include investigation of flow past roughened plates, and experiments with small models of spillway dams and weirs to determine causes of scour in the river bed below a dam. The resistance laws for flow in open channels have been studied by experiments with artificially roughened beds.

*No. 2—December 1936.*

*No. 3—January 1937.*

*No. 4—February 1937.*

These have been included in *Quarterly Bulletin No. 5.*

*No. 5—March 1937.*

#### THE SALONIKA PLAIN RECLAMATION-WORKS.

Huntsman.

The Salonika Plain in Greece is a low-lying plain over 500 sq. miles in extent of comparatively recent formation and is composed of alluvium deposited by the rivers flowing through the plain. In 1925, the Hellenic Government entered into a contract with an American engineering company of New York whereby the company was entrusted with the execution of works of drainage, flood protection, regulation of rivers, improvement of communications and irrigation within the Salonika Plain. The object was to reclaim a large area of the plain and protect it from floods so that it could be utilized for cultivation. This paper deals with the design and construction of the whole of the project with the exception of the irrigation works. The works described include drainage channels river diversions, protective embankments, a circulatory canal to collect the discharge of the smaller streams and torrents river training works and a large number of bridges. Details of construction and organization, and results of the first year's operations are given.

#### THE LAKE COPAIS, BOROTA, GREECE: ITS DRAINAGE AND DEVELOPMENT.

Dean.

The Copais plain in Greece is a natural basin about 130 sq. miles in area entirely surrounded by hills and mountains. This basin is 100 metres above sea level but there are no outlets for the water that flows into it and until recently it was largely a lake of varying depth. Various projects to drain the basin were formed, beginning in 1846, but none materialized until 1887 when a British company took over

the unfinished project of a French company and completed it a few years ago. The drainage works comprising the project are described, and principle features of the design of the works are mentioned. The results and benefits accruing from the completion of the drainage works is reviewed.

**FUNDAMENTAL RESEARCH ON THE APPLICATION OF  
VIBRATION TO THE PRE-CASTING OF CONCRETE.**

Stewart.

This paper presents results of experiments conducted by the author to determine the effect of vibration on concrete. The object was to try to establish a relationship between acceleration and density at a number of frequencies. The apparatus used is described, and other phenomena observed during the tests are discussed. The results of the experiments are presented graphically. The water content ratio and its bearing upon the strength of the finished product are discussed.

**FLOOD-HYDROGRAPHS.**

Richards.

This paper is in two parts. The object of Part I of the paper is to put forward formulæ for the calculation of maximum intensity of flood and to arrive at curves indicating its rise and fall. The important factors affecting floods are given and the method of flood estimation put forward provides for all these factors. From the formulæ given, the flood hydrograph can be prepared. In conclusion, the author points out the limits of applicability of the formulæ and says that formulæ and recorded data are complementary in as much as the latter enable the values of co-efficients used in the formulæ to be determined while the formulæ can be used for catchments where sufficient data are not available.

Part II of the paper deals with the effect of a flood on a storage reservoir and describes a method whereby reservoir lag-effect and the maximum height to which the water level of the reservoir will rise with a given length of waste weir can be determined.

**ENGINEERING RESEARCH ;**

Interim report No. 1 of the sub-committee on vibrated concrete has been published. The report describes the machine employed, the details of concrete mixture used and the tests carried out. Results of tests are discussed and conclusions drawn from the results are summarized.

**RESEARCH WORK IN ENGINEERING AT VICTORIA  
UNIVERSITY, MANCHESTER, FEBRUARY, 1937.**

Hydraulic research includes work in the development of the theory of dynamic similarity and investigations by models.

Investigations with models of the Severn Barrage and Severn Estuary have been completed, and a study is being made by means of a model of the effect of certain cut-offs in the river Mersey with a view to preventing floods.

*No. 6.—April 1937.*

#### KINCARDINE-ON-FORTH BRIDGE.

Brown.

This paper describes the design and construction of the Kincardine-on-Forth Road Bridge which was completed in October, 1936. The bridge consists of—

- (1) Three continuous spans of 62 ft. 6 inches.
- (2) Fourteen steel spans of 100 ft.
- (3) A centre swing span of steel of 364 ft.
- (4) Nine reinforced concrete spans of 50 ft. with an arched underside.
- (5) A piled reinforced concrete viaduct 265 ft. long.

The selection of site, setting out, details of piers and foundations, the swing and other spans, details of turning machinery of the swing span, and operations during the construction are described.

#### THE NORTH BIHAR GROUP OF THE RIVERS AND WATERWAYS OF THE GANGETIC PLAIN BEFORE AND AFTER THE EARTHQUAKE OF THE 15TH JANUARY, 1934.

Abstract of a paper describing the characteristics of the rivers of North Bihar. The Gangetic plain in Bihar is being raised by detritus brought down by the rivers from the hills. The North Bihar rivers are discussed individually and certain conclusions arrived at which show that it would be best for the country to be evenly raised by the rivers running through one low place after another, the rivers being guided by digging channels rather than by building embankments.

#### ENGINEERING RESEARCH.

The Sixteenth Interim Report of the Committee of the Institution of Civil Engineers on Deterioration of Sea Structures has been published. A report is included on the deterioration of reinforced concrete test pieces in sea water. The experiments indicate the need for adequate cover over the reinforcements. Results obtained with high aluminous cements are inconsistent and further work is being carried out thereon.

## THE ROYAL ENGINEERS JOURNAL.

VOL. LI.

*June 1937.*

## FLOODS IN FENLAND.

Heath.

A large part of the Fen country is below sea level and the whole of it together with the Wash may be regarded as an arm of the North Sea which has been filled up with silt by the many rivers which enter it. The major portion of the present works to keep the sea out owe their inception to Francis, Earl of Bedford. In the spring of 1937, a large part of Fenland suffered from excessive floods and detachments of Royal Engineers were sent to the Fen area to help in fighting the floods. In this article a short description of the engineering works in the Fen area is given followed by a discussion of the causes contributing to the occurrence of the floods. The work done to control the floods and prevent further damage are then described.

## THE SEVEN-LENS AERIAL CAMERA.

Thompson.

Describes the seven lens camera used in aerial photography and explains its functions.

## WATER AND WATER ENGINEERING.

VOL. XXXIX.

*No. 476.*

Not yet received.

*No. 477—April 1937.*THE AUTOMATIC FLAP WEIR AT THE WUNDERKLINGEN  
PUMPING STATION.

Ringger.

Describes an arrangement of automatic flaps recently installed on the top of a weir to hold up water for the Wunderklingen pumping and electricity generating station. Eleven flaps have been installed. Each flap consists of a wooden plank bolted to an iron frame which is provided with journals turning in bearings at the lower end. The flap rests in a vertical position when water is held up. There are stops to prevent the flap from turning too far on the upstream side. The water pressure on the upstream face of the flap is balanced by a system of counterweights which exert a pull through wire ropes moving on pulleys at the lower end of the flap. The counterweights can be so adjusted that a rise in the level of the impounded water beyond a specified height would tend to raise the counterweights and turn the flap in the direction of the flow of water. When the

river is in high flood, the flap rests in a horizontal position on the top of the weir. Details of the flap are described and illustrated by diagrams.

#### RECENT FLOODS IN U. S. A.

Review of an address before the Royal Meteorological Society on the recent American floods. The meteorological circumstances which caused the disastrous floods are discussed. Though the flood heights attained in 1937 were in excess of any previous floods, the damage to life was comparatively less due to accurate forecasts of times and heights of flood stages made by the U. S. Weather Bureau.

*No. 478—May 1937.*

#### EDITORIAL NOTES.

##### THE UTILISATION OF UNDERGROUND WATER RESOURCES.

In a paper recently read at the Junior Institute of Engineers it is stated that in a water well installation in the city of London for an office block, the capital cost of boring, pumping plant, etc. is repaid in about 4 years by the saving in water rates. In the case of a bore hole where no pumps are necessary, the well will pay for itself in six months. In an air attack, bore holes would be perfectly safe while present installations such as water tanks, pumping stations, etc., could be easily damaged. The life of a bore hole may be anything from 30 to 60 years. The possibilities of utilizing underground water should be explored.

##### WATER SUPPLY OF HONG KONG: THE SHING MUN SCHEME.

Smith.

Describes the construction of the Shing Mun Dam (see page 28 of Bulletin No. 5).

##### LETTER TO THE EDITOR.

##### TIDAL MODELS.

Lacey.

An abstract of this letter has already appeared on page 158 of Bulletin No. 5.

*No. 479—June 1937.*

##### WATER LEVEL, FLOW GAUGING AND METEOROLOGICAL STATIONS: THEIR GRAPHICAL RECORDS, AS THE BASIS OF WATER SURVEY ON RIVER SYSTEMS. PART I.

McClellan.

In this article is described the procedure of water survey of a river system with the object of obtaining complete information in regard to the water available in the system.

The general scheme of survey includes the establishment of permanent water level recorders on rivers at selected sites, the measurement of the flow, setting up and recording rain gauges where necessary, and compilation of records of water level, flow, rainfall, etc., in a form suitable for any analysis.

#### TESTING OF AGGREGATES FOR DURABILITY IN CONCRETE.

Goldbeck.

The most widely accepted, accelerated durability test is the sodium sulphate test. Aggregate samples are prepared by the use of designated sieves. The samples are then immersed in a saturated solution of sodium sulphate for 18 hours at 21 deg. cent., drying the sample to constant weight in an oven maintained at 105 deg. cent. to 110 deg. cent., cooling to room temperature and again immersing in the solution of sodium sulphate. Five cycles of this test are required for concrete aggregates. Finally the samples are washed free of sodium sulphate and dried. Each sample is then sieved through the same size sieve as was used in preparing the original sample. The quantity passing through the sieve is considered uncound.

There are many factors which interfere with obtaining consistent results in different laboratories. Recent investigators have made special recommendations for improving the test so as to obtain consistent results and some of these are mentioned. The test is not however considered sufficiently reliable for use in setting definite test limits in specifications and should be used only as danger signals.

#### LETTER TO THE EDITOR. TIDAL MODELS.

Mr. J. Allen comments on Mr. Gerald Lacey's letter on the tidal model of the river Great Ouse and The Wash published in the May 1937 issue of the Journal. He compares the vertical exaggeration actually adopted with that required by Mr. Lacey's formula in the case of a number of models and has shown the wide difference between the two. With regard to Osborne Reynold's Mersey experiments the applicability of Mr. Lacey's formula to Reynold's models may be in the nature of a coincidence. He mentions the advantages of beginning with a vertical exaggeration on the large side in tidal model investigations which may be followed up by a further examination on a reduced vertical exaggeration model.

## DEMAG NEWS.

VOL. XI, B.

No. 1—March 1937.

There is nothing of interest to irrigation engineers in this issue.

## DIE BEAUTECHNIK.

(In German.)

VOL. 14.

No. 19—May 1, 1936.

APPLICATION OF ELECTRO-CHEMICAL METHOD FOR  
MAKING THE FOUNDATION OF PILES IMPERVIOUS.

This describes a laboratory experiment. "In driving piles the structure of clayey soils becomes strongly disturbed. Therefore the foundation piles have correspondingly lesser bearing capacity which depends on the friction between the surface of the piles and the disturbed soils. By the electro-chemical method of making soil impervious it is possible:—

1. to increase the friction between the pile and the clayey subsoil, and
2. to create a zone of imperviousness round the pile many times the diameter of the piles.

Thus will the bearing capacity of electrically made impervious piles be increased considerably. This capacity can be raised ten times or more, the longer the current flows and the higher its voltage".

(Translation of the article is also available.)

## SCHWEIZERISCHE BAUZEITUNG.

(In German.)

VOL. 104.

No. 24—December 15, 1934.

There is nothing of interest to irrigation engineers in this issue.

VOL. 105.

No. 1—January 5, 1935.

A NEW ACOUSTICAL METHOD OF MEASUREMENT FOR  
THE DETERMINATION OF PRESSURE RELATION-  
SHIPS IN EARTHEN DAMS.

It is described in detail in "Wasserkraft und Wasserwirtschaft" No. 17 of 2nd September 1934. The apparatus is very simple and consists of a receiver and a measuring device, which is a steel chord under tension and serves as the



sound producing element which can be attached to different points of the object under investigation. The sounds produced are compared with those of a standard chord and pressures can be determined. For the determination of pressure distribution on the foundations of structures, a measuring box is used which contains all the important parts of the apparatus.

(Translation of the article is also available.)

## VIZUGYI KOZLEMENYEK.

(In Magyar but containing English summaries.)

VOL. XVIII.

No. 3—*July-September 1936.*

### TYPES OF DAMS EMPLOYED IN THE CANALISATION OF THE MAINE AND NECKAR RIVERS.

Main types of dams and their features in the canalisation works of the Maine and Neckar rivers which are in progress are described in this article. Three types are dealt with, namely, the sluice gate type, the segmental type and the rolling type.

### THE PNEUMATIC FOUNDATION.

This article describes the methods, the means, and the historical development of the pneumatic foundation, and conditions of working in such foundation. Some recent instances of the use of pneumatic foundation are cited.

## REVUE GENERALE DE L'HYDRAULIQUE.

(In French.)

No. 13—*January-February 1937.*

### A NEW EXPERIMENTAL CONTRIBUTION TO THE STUDY OF THE LAWS OF SIMILITUDE OF HYDRAULIC TURBO-MACHINES: RUNNING OF A HELICAL TUR- BINE UNDER A VARIABLE HEAD: INFLUENCES OF MECHANICAL LOSSES AND OF CAVITATION.

### EVAPORATION AND THE DEFICIENCY OF FLOW IN THE REGION OF THE MEDITERRANEAN: SYSTEMATIC OBSERVATIONS OVER A LONG PERIOD OF THE EVAPORATIVE POWER OF A REGIM PROVIDING A CONTRIBUTION OF THE GREATEST INTEREST TO THE DEFICIENCY OF FLOW.

### EXPERIMENTAL RESEARCH ON THE RATING OF CUR- RENT METERS IN STILL WATER. (Concluded from previous issues.)

This article gives the conclusions arrived at from the experiments.

**THE QUESTION OF THE REJECTION OF AUTHORIZED  
PROJECT BEFORE JURISPRUDENCE. (Con-  
cluded from previous issues.)**

This article deals with the legal rights of hydro-electric projects.

*No. 14—March-April 1937.*

**A NEW EXPERIMENTAL CONTRIBUTION TO THE  
STUDY OF THE LAWS OF SIMILITUDE OF HY-  
DRAULIC TURBO-MACHINES. (Concluded from  
Issue No. 13.)**

Conclusions of the experiment are given in this article.

**A CONTRIBUTION TO THE CALCULATION OF THE RE-  
INFORCEMENT OF JOINTS IN PIPES.**

**THE CATASTROPHIC FLOODS OF MARCH 1936 AND  
JANUARY-FEBRUARY 1937 IN THE UNITED STATES.**

**Parde.**

**FAMOUS PRECURSORS IN HYDRAULIC: THE DIVERSE  
AND INGENIOUS MACHINES OF CAPTAIN AUGUS-  
TIN RAMELLI.**

**THE AGRICULTURAL JOURNAL OF INDIA.**

(Special Indian Science Congress Number, 1916.)

**IMPORTANCE OF SOIL-AERATION IN FORESTRY.**

**Hole.**

This article deals with the damage that may be done to the seedlings of the Sal tree by insufficient soil-aeration when the physical condition of the soil is apparently suitable for growth.

**THE IMPORTANCE OF SOIL VENTILATION ON THE  
ALLUVIUM.**

**Howard.**

A full supply of air in the soil is as important as a sufficiency of water. Some examples of the effect of improved soil ventilation on the growth of crops are quoted and discussed.

**THE AQUATIC WEEDS OF THE GODAVARI AND PRA-  
VARA CANALS OF THE BOMBAY PRESIDENCY.—A  
PROBLEM IN APPLIED ECOLOGY.**

**Burns.**

The author was called upon to examine and report on the weed growth in the Godavari and Pravara Canals. The result of his studies are presented in this paper. He classifies the weeds found, describes the growth of the most common weed, and discusses its ecology. The canals have

been infected from the lake from which they draw their supplies. Reasons for the extraordinary prevalence of the weed in the lake are discussed. Variations of turbidity or velocity of water seem to have little effect on the weed. Prolonged closure of canals would kill the weeds but a closure which is sufficient to kill the exposed stems does not affect the underground roots which begin growing when water is again let into the canal. Methods for control should aim at prevention of fruit formation in the lake, repeated cutting or dredging by suitable apparatus in the canal, and uprooting the plants established.

THE CORRELATION OF RAINFALL AND THE SUCCEED-  
ING CROPS WITH SPECIAL REFERENCE TO THE  
PUNJAB.

Jacob.

The author has attempted to determine correlation of rainfall and areas sown, and of rainfall and outturn with a view to evolve a means of forecasting the amount of crop of any harvest. The correlations are based on the figures of the thirty years 1886—1915, and pertain to a tract in the Jullunder Tahsil of the Jullunder District in Punjab. A formula for prediction of the sown area of well irrigated wheat based on the correlations has been derived, as well as a formula giving the percentage of failure of crop.

## AGRICULTURE AND LIVE-STOCK IN INDIA.

VOL. VII.

*Part II—March 1937.*

### THE NEW SLOTTED POTTERY STRAINER.

Describes a new type of strainer for wells and tube wells. The strainer consists of cylindrical pipes of hard burned clay with vertical slots cut in the wall of the cylinder. The pipe elements are three inches in length, and two such elements built one above the other in a mild steel bar frame with aluminium end joints form a strainer unit. It is being sold to the well owners at Rs. 3-8-0 per foot.

*Part III—May 1937.*

### FACTORY CANE-MOLASSES AS A CATTLE FEED.

Labh Singh.

Gambhir Singh.

A suitable use for molasses which is a by-product of the sugar industry has engaged the attention of research workers for sometime past. This paper describes an experiment to determine the food value of factory cane molasses for bullocks, conducted at Lyallpur, Punjab. The results of the experiment are discussed and it is concluded that 2 lbs. of factory molasses could replace 2 lbs. of maize in a mixed ration for bullocks in the winter season.

## NOTES.

## BOARD OF AGRICULTURE AND ANIMAL HUSBANDRY. CROPS AND SOILS WING, 1937.

At the invitation of the Punjab Government, the second meeting of the Crops and Soils wing of the Board of Agriculture and Animal Husbandry will be held in Lahore from 6th to 11th December 1937. The next two days will be spent on a tour of inspection in Lyallpur.

## GLEANINGS FROM HERE AND THERE.

(Issued by the Associated Cement Companies, Ltd., Bombay.)

No. 1.

No. 2.

In these issues there is nothing of interest to irrigation engineers.

THE INDIAN JOURNAL OF AGRICULTURAL SCIENCE.  
VOL. VII.

*Part I—February 1937.*

STUDIES IN CROP ECOLOGY : THE COMPOSITION OF THE  
COTTON CROPS OF CENTRAL INDIA AND RAJ-  
PUTANA.

Hutchinson.  
Ghose.

The Malvi cotton of Central India is believed to have deteriorated to a considerable extent in recent years. This paper reports the studies undertaken in an attempt to secure from the crop itself, satisfactory evidence concerning the alleged deterioration. The past history and the present status of the cotton crop in Central India has been investigated with a view to discover the causes and estimate the extent of deterioration. Information on Rajputana cotton crop has also been collected and is discussed. It is shown that the opinions of the local industry and the theories offered with regard to the deterioration are not supported by facts.

VARIATION IN THE CHARACTERS OF COTTON IN RELATION TO THE POSITION OF BOLLS ON THE PLANT. Sen. Mohd. Afzal.

This paper presents results of experiments conducted in an attempt to study the effect of position of bolls on the cotton plant on fibre length, fibre mass per unit length, and mean proportion of mature fibres. Study was also made of the extent to which the effect of climate supervened that of the position of bolls on the plant. Results are discussed and conclusions are summarized.

**STUDIES IN THE WATER RELATIONS OF RICE : EFFECT  
OF WATERING ON THE RATE OF GROWTH AND  
YIELD OF FOUR VARIETIES OF RICE.**

Sen.

Rice is a crop which is grown under very wet conditions. Experiments recently conducted show however that water requirements of this plant are similar to those of rye. The tradition therefore that very wet conditions are necessary for the growth of rice requires investigation. In Bengal and Assam rice is cultivated under a variety of conditions. Some fields are submerged under several feet of water during the growth of the plant, and others are on higher land and are irrigated by artificial means. In some parts of Bihar and Orissa, the practice is to drain the rice fields at certain stages of the crop, and to replace standing water by fresh water. All these facts point to the necessity of an investigation of the response of the plant to various water conditions. This paper presents the results of an experiment on the effects of watering on the rate of growth and yield per plant of four varieties of rice cultivated in Bengal.

**HETEROSIS IN RICE.**

Kadam.  
Patil.  
Patankar.

The luxuriant growth noticed in the first generation hybrids in most of the cereals and other crops is called "heterosis". This paper presents data on heterosis of the rice plant from crosses which were made for economic purposes.

**INHERITANCE OF SHEATHED EAR IN RICE.**

Sethi.  
Sethi.  
Mehta.

This paper deals with the inheritance of a peculiarity in rice consisting in the retention of the panicle within the leaf sheath. This peculiarity is noticed in one variety of rice grown in the United Provinces and this variety escapes the attack of the rice fly on account of this peculiarity. The inheritance of this protective natural device was studied and the results are presented in this paper.

*Part II—April 1937.*

**STUDIES ON THE ROOT-ROT DISEASE OF COTTON IN Vasudeva.  
THE PUNJAB.**

This paper describes experiments with two organisms which are responsible for the root rot disease of cotton in the Punjab. Toxic effects of various chemical compounds on these organisms has been investigated in connection with the study of methods of control of the disease.

**MOLASSES AS MANURE IN THE UNITED PROVINCES.** Batham.  
Sethi.  
Nigam.

This paper describes the investigations carried out by the Agricultural Department of the United Provinces of the use of molasses as manure and summarizes experience in other countries. Conclusions arrived at from the results of the investigations are given. The more important amongst them are :—

1. The effect of molasses as manure is more appreciable on poor than on rich soils.
2. Molasses do not produce as high a yield of wheat as compost or cow dung but the increase of yield is appreciable in comparison to no manure.
3. Nitrogen fixation is enhanced in soils by the application of molasses.

**CURRENT SCIENCE.**

VOL. V.

*No. 9—March 1937.*

Nothing of interest to irrigation engineers in this issue.

*No. 10—April 1937.*

**NEED FOR A SOIL SURVEY OF INDIA.**

A discussion on the need of a soil survey of India was held during the Indian Science Congress week at Hyderabad in January 1937. The President in introducing the subject said that a soil survey could be carried out for one or more of many purposes. It could be carried out for settling new land, for ascertaining the physical and chemical characteristics of the soil with reference to manurial treatment, and for irrigation projects. There are about 150 million acres of cultivable waste land scattered all over India and it is necessary to ascertain the nature and the disposition of this waste land with a view to find out the most promising areas for reclamation. Survey for classification of soils is necessary for research and advisory work. He invited the speakers to suggest methods of survey that might be considered necessary on an All-India basis. Sir John Russell in the course of his address said that he attached great importance to a proper soil survey of any region where irrigation is to be introduced. Trouble from waterlogging is likely to follow irrigation unless the scheme has been planned as guided by a previous soil survey. Other problems of soil survey arise in connection with forestry. The proposal that Indian Soil workers should constitute a Committee to draw up an

agreed basis for describing the soils and should indicate the methods of examination to be adopted was put forward by a speaker and Sir John Russell considered it a sound proposal.

A note prepared by Dr. R. McLagan Gorrie was read. The note stressed the importance of considering the protective and water storage aspects of natural plant cover before deforesting soils for agricultural purposes. Any form of soil survey should register the relative efficiency of the existing plant cover in maintaining the optimum soil profile and should indicate the trend of changes in the existing profile.

#### SCIENCE NOTES.

Kamesam.

WOOD IS GOOD (Bulletins of the timber development section of the Forest Research Institute, Dehra Dun.)

Propaganda has been started by the Forest Research Institute with a view to advertise wood as a building material. In Europe and America, timber is looked upon as an important structural material while in India it is "nobody's child and has gone by default."

No. 11—May 1937.

#### RESEARCH ITEMS.

In *J. Res. National Bureau of Standards*, 1936, 16, a rapid method for the determination of silica in Portland cement has been described. The method consists in mixing the sample of cement with an equal quantity of ammonium chloride, digesting the mixture with hydrochloric acid for half an hour and filtering off the silica.

#### SCIENCE NOTES.

The Sugar Committee of the Imperial Council of Agricultural Research held a two day session on May 3rd and 4th, and discussed various problems connected with the Sugar Industry. The Committee considered the serious situation arising from the alarming expansion of the acreage under cane resulting in the production of cane far in excess of that for which there is demand. The Committee were of opinion that sugarcane cultivation should be spread over specially marked zones in the vicinity of particular factories. Proposals for carrying out a proper marketing survey of sugar were approved.

The Maynard Ganga Ram prize for 1935 was awarded to Mr. J. C. Luthra, Professor of Botany for his researches on the control of loose smut disease of wheat.

The award for 1932 has also been announced and goes to Mr. T. A. Miller Brownlie for his invention of a slip strainer suitable for augmentation of water supplies from bores sunk in open wells.

The silver jubilee session of Indian Science Congress will be held in Calcutta in January 1938. List of the various sections with names of Presidents is given.

*No. 12—June 1937.*

#### REVIEWS.

##### THE SPOTTED BOLLWORMS OF COTTON IN SOUTH GUJARAT, BOMBAY PRESIDENCY BY DESHPANDE AND NADKARNY.

The book deals with the results of investigations of the spotted bollworm carried out at Surat for 8 years from 1923 to 1931. The occurrence of bollworms in different parts of the world and in different places in India is discussed and the damage done to the cotton crop is described. Control methods tried by the authors are dealt with. The results of the investigations are useful not only to Gujarat but to different parts of India where cotton is grown.

##### SOME ASPECTS OF THE CHEMISTRY OF SWAMP SOIL. Subrahmanyam.

This article reviews certain chemical aspects of swamp soils having a bearing on the nutrition of the rice plant. In certain regions, specially river deltas, the yield of rice is maintained at a fairly high level without the application of manure. This high level of fertility is traceable to river silt. The bio-chemistry of river silt has not yet been adequately studied. The quantity of silt carried by different rivers, the amount deposited in different seasons, its distribution over the fields and its contribution to crop growth are problems awaiting solution. There is no doubt that some of the silts are rich and contain 3,000 parts per million of nitrogen. There is also evidence to show that river silt facilitates oxidation changes. In recent years evidence has been adduced to show that one of the causes of preservation of the fertility of swamp soils is the fixation of atmospheric nitrogen. The researches are worthy of extension. The influence of river silt on the nitrogen content of the soil is a subject which needs careful study. The writer then reviews some chemical changes which occur in swamp soils, and their bearing on the rice plant and indicates the problems which are worthy of further study. A striking feature about cultivation of rice is the enormous quantity of water required. The available evidence would suggest that swamp soils provide certain constituents which are not available in the dry soil, one of these being silicon. Probably there are many others which are necessary to the rice plant, and are released under swamp soil conditions. If the nature of these substances is determined it may be possible to provide them to the plant in dry soil conditions. A bibliography on the research work done on the subjects discussed is appended.



## THE ENGINEER.

[A monthly official organ of the Mechanical Engineers' Association (India).]

VOL. XV.

No. 1—January-March 1937.

SOME NOTES ON TUBE-WELLS AND AIR-LIFT PUMP-ING.      Vora.

This paper contains information collected from various sources on the hydro-electric and tube-well scheme in United Provinces, and details of tube well scheme for water supply of Cawnpore. Tube-well work in Baroda State is also briefly described. The drilling of wells and the equipment used are dealt with and the method of air lift pumping for raising water is discussed in detail. Some types of deep well pumps such as reciprocating pumps, and centrifugal pumps are described.

## THE INDIAN &amp; EASTERN ENGINEER.

VOL. XXX.

No. 4—April 1937.

EDITORIAL NOTES.

## FLOW OF WATER IN PIPES AND OPEN CHANNELS.

In a previous issue (See page 42, Bulletin No. 4) it was mentioned that a sub-committee of the Research Committee of the Institution of Civil Engineers has been appointed to investigate the problem of flow in pipes and open channels. An article by A. Auric in "*La Technique Moderne*" shows that experiments on this subject are also proceeding abroad. The author gives the working of a formula with explanation of terms for determining the product of surface slope by gravity, and suggests the advisability of the consideration of wind, surface, agitation, and atmospheric pressure. According to experiments there exists a veritable distinction between the laminar regimen and the turbulent regimen and it is necessary to adopt distinct formulæ for each case.

## MODERN ROAD CONSTRUCTION.

Taylor.

Continuation of article in the previous issue (See page 57 of Bulletin No. 5). Describes surfacing with cement macadam, and resurfacing waterbound macadam roads with a 2-inch thick concrete slab. Drainage culverts of the box type, and other types are described.

## THE STUDENTS CORNER.

Antia.

The general conditions which should be incorporated in a contract document are given in this article.

*No. 5—May 1937.*

## AN ELECTRIFIED CANE-SUGAR FACTORY.

Godfrey.

Natal Estates, Ltd., own 30,000 acres of land of which 20,000 acres are under sugarcane cultivation. In the centre of this area is a sugar factory. Recently a comprehensive electrification scheme has been carried out in the sugar factory, details of which are presented in this article. A large power station with 3 turbo-alternators has been completed. The power will be utilized for driving the cane crushing and milling machinery, and for pumping water from the river Umgeni to a canal system for irrigation of the estates owned by the Company. The power house equipment, the milling plant equipment and the irrigation system are described.

## METER FLUME DISCHARGE TABLES.

Blench.

This article gives a new method of preparing discharge tables for simple flumes and multiple flumes with a common exit. The method is based on 'The principle of least squares'. At the outset a preliminary discussion of the flume formulae is given. The principle of least squares is then explained, and its application to the case of a simple flume is illustrated. Preparation of discharge table is explained, and the probable errors are discussed. In Part II of the article the method is extended to solve the problem of discharges through multiple flumes with a common exit. The article is accompanied by a number of tables illustrating the solution of actual examples.

## THE STUDENTS' CORNER.

Antia.

Some general conditions pertaining to contracts including those concerning payment, inadequacy of progress, stoppage of work, claims, and disputes, are dealt with in this article. Extracts from the general conditions of a particular contract are given at the end to illustrate some of the points dealt with.

*No. 6—June 1937.*

## EDITORIAL.

## WATER SUPPLY IN THE UNITED PROVINCES.

Review of the Ganges Valley State Tube Well Irrigation Scheme now under construction. The scheme provides for a net work of state tube wells at intervals of about  $1\frac{1}{2}$  miles.

Wells already sunk are of an average depth of 260 ft. yielding 33,000 gallons per hour. The cost of works for a complete tube well with electrical equipment is approximately Rs. 8,000.

#### VIBRATED CONCRETE.

Review of interim report No. 1 of the Joint Sub-Committee of the Institutions of Civil and Structural Engineers set up in 1935 to study the effects of vibration on concrete particularly in relation to the effects upon the setting and ultimate qualities of the concrete. The report contains details of all tests undertaken together with diagrams and tabular results. The conclusions arrived at in the report are set forth in this review.

#### LONG RANGE EXCAVATING.

Taylor.

Describes the general principles of the drag scraper, principal features of the equipment, and the use of the equipment in construction work such as building of levees, excavation of canals, deepening of rivers and in tunnel work.

#### THE BOULDER DAM.

Mr. Savage, Chief Designing Engineer, Bureau of Reclamation, U. S. A. was in England recently and delivered a lecture on the Boulder Dam before the Institution of Civil Engineers. The lecture was illustrated with films and lantern slides. The preparatory work included the building of a 33 miles long branch railroad, 32 miles of highway and a 200 ton cable way with a span of 1,256 ft. The construction facilities included 45 miles of standard gauge railroad complete with rolling stock, 20 miles of construction roads aggregate processing plant, cement blending plant, concrete mixing plant, and a 825 ton refrigeration plant for cooling mass concrete in the dam. The main features of the dam are described. The dam is a concrete arch gravity dam 726 ft. high, 45 ft. thick at top and 660 ft. thick at the base. Other structures such as spillways, intake towers, and power plant building are described briefly.

#### THE STUDENTS CORNER.

Antia.

Specifications for work describing the character and quality of materials to be used and methods to be employed in the execution of a work form part of a contract document. The points which should be borne in mind in drawing up specifications are described, and general specifications for some items of work are given.

## INDIAN CONCRETE JOURNAL.

Vol. XI.

No. 4—April 1937.

## DESIGN OF REINFORCED CEMENT CONCRETE BEAMS.

Desai.

Sahani.

A method of designing R. C. beams is given in this article. The method is based on the use of a number of charts prepared by the author and lengthy and tedious computations are eliminated. The method of using the charts has been illustrated by a number of examples.

## PROPORTIONING CONCRETE MIXTURES.

Reynolds.

This is in continuation of the article in the previous issue. Two methods of proportioning are described: proportioning by trial, and proportioning by the "fineness modulus" method. When supplies are available it is sometimes convenient to use a mixed aggregate. The factors to be taken care of when using such a mixed aggregate are mentioned. In mass concrete work it is justifiable economy to build in 'plums' as the work proceeds. These plums can be blocks of stone or portland cement concrete not greater in size than can be handled by a man. Sharp cornered blocks should be avoided.

## CEMENT FOR SUBGRADE STABILISATION.

'Stabilized soil cement' is the technical name of the newest type of road construction now under experiment in South Carolina. Fundamentally the process consists of mixing dry cement with the road soil that nature provided, pulverising it, moistening it, then packing it into a dense impervious mass, and finally rolling it to a smooth surface. An experimental project, consisting of 3.3 miles of a state highway treated in the manner described above has been completed recently. Details of construction procedure, equipment and working crew required, and other details are described in the article.

No. 5—May 1937.

## NEWS AND NOTES.

The Irrigation Department of Bengal decided to gunite the Anderson Weir. The work is now in progress.

## THE INCREASED USE OF VIBRATED CONCRETE.

The adoption of high frequency vibrators for placing concrete has been more rapid than the progress in acquiring basic information on such factors as frequency, amplitude, size

and type of vibrator, period and method of application of vibration, etc. This article sets forth some recommendations with regard to the practice of vibration as applied to concrete.

#### STEEP CONCRETE FACE ON ROCKFILL DAM IN CHINA.

This article describes the Shing Mun dam in Hongkong. (See Bulletin No. 5, page 28).

#### PROPORTIONING CONCRETE MIXTURES.

Reynolds.

Continued from previous issue. The method of measurement of materials in batch-boxes is described, and the manner of constructing batch-boxes is given.

*No. 6—June 1937.*

#### PRE-CAST UNITS TURNED OUT FROM MOULDS IMMEDIATELY AFTER CASTING.

M. Mopin a French Engineer has developed a new method of rapid production of precast concrete units. This is made possible by a system of vibration which with suitably graded aggregates gives to the concrete a gelatinous nature which allows it to be turned out of the mould immediately without damage. Recently a few housing schemes have been erected making use of pre-cast units on the Mopin system. This article describes some of the methods employed in the manufacture of pre-cast units. The descriptions are accompanied by numerous illustrations.

#### CONCRETE PAVEMENT IN SWAMPS.

Describes a type of road construction used in North Carolina for marshy soils. The least expensive type of construction in marshy soil has been found to be a reinforced concrete slab resting on piling.

#### REMOVING STAINS FROM CAST STONE AND CONCRETE.

Baumgarten.

Recipes for cleaning cast stone and concrete which have proved successful are given in this article.

#### REINFORCED CONCRETE WELLS IN BARODA STATE.

Ootia.

The geological formation of the upper strata in the Meshana District in Baroda is mainly of sand. In sinking masonry wells, a sandy current would often be encountered from one side or the other of the well. Sometimes the force of sand tends to blow up the masonry walls of the well. Reinforced concrete wells were therefore decided upon and this construction has proved successful. The method of sinking reinforced concrete wells is described and details of wells and well curbs are given.

## PROPORTIONING CONCRETE MIXTURES.

Reynolds.

Continued from previous issue. This article deals with reduction in bulk of concrete after mixing, and the method of determination of the proportions of mixed concrete.

## INDIAN ENGINEERING.

VOL. C. I.

*No. 4—April 1937.*

## NOTES AND COMMENTS.

The hydroelectric scheme now under construction in Fyzabad, U. P. is expected to be completed in August next and will irrigate 44,000 acres besides providing cheap power for the tube wells and cottage industries. Provision has been made in the scheme for future expansion on the lines of the Ganges canal grid system where within the last 5 years the total consumption has increased from 14,000 units to 2,500,000 units.

## SIPHON SPILLWAY.

Joshi.

Design for a High Masonry Dam.

This paper illustrates the principles of design of a siphon spillway for a masonry dam. This type of spillway is of recent development and possesses many advantages. There are no moving parts such as chains and gates. The siphon is automatic in starting and stopping, and acts with the full capacity immediately the priming level is reached. The procedure of design is illustrated by an actual example which is worked out fully.

## SURVEY OF INDIA.

A review of the annual report of the Survey of India Department for the year 1936. Though the country is being mapped at the rate of 40,000 sq. miles a year, approximately 15 more years will elapse before a complete modern map of India is available. The early history of the Survey of India Department, and the progress and development of surveys are outlined in brief.

## RAMPUR STATE TUBE-WELL SCHEME.

Abstract of a speech by Sir William Stampe, Chief Engineer, United Provinces on the occasion of the inauguration of the Rampur Tube-Well Scheme. A system of 34 tube-wells worked by electricity generated at Salawa power

station on the Ganges Canal some 200 miles away is proposed, of which 10 tube-wells were opened, in the first instance. Sir William Stampe said that as a result of recent inquiries, the stability of the underground water-table can be relied upon. Cheap electric power is not only helpful in extending irrigation by pumping but enables the grower to process his grain. The material benefits derived such as reduction in cost of agriculture are mentioned. The development of social amenities round tube wells such as tanks for drinking water, masonry bathing pools, cattle tanks, and the radio, was suggested on the lines now being explored in the United Provinces.

*No. 5—May 1937.*

#### CO-ORDINATED RESEARCH.

In this article the editor puts forward a plea for the establishment of an all Empire organization for co-ordinating engineering research carried out all over the British Empire on the same lines as the Executive Council of the Imperial Agricultural Bureaux.

#### NOTES AND COMMENTS.

A preparation with the trade name "Inertol" which is a bituminous waterproofing compound for steel and concrete has recently been put on the market and is being extensively used, specially in corrugated iron roofing. It is manufactured in India.

A liquid waterproofing material for use in filling cracks on roofs, for joints in concrete and glass, and for construction of damp course is termed "synthaprufe". It is of the consistency of milk which sets in a short time.

#### HOME AND ABROAD.

The Menai Suspension Bridge built by Thomas Telford in 1826 is to be reconstructed at a cost of £228,000. The main features of the old bridge will be retained. There will be fewer chains and footpaths will be added on both sides.

#### DETERIORATION OF STRUCTURES IN SEA WATER.

Review of the sixteenth report of the special committee nominated by the Institution of Civil Engineers to investigate the deterioration of structures in sea water. It was found that treatment with creosote was the best remedy, but without the addition of any other chemical it was not so effective as a mixture of Creosote and D. M. With regard to metals it was found that only chromium and nickel steels are resistant to action to any extent. Galvanized steel plates show high resistance to corrosion. Experiments on concrete show that no one cement has marked superiority in

withstanding sea action. Resistance increases with richness of mixture, and concrete of dry consistency is more resistant than that of normal constituency. Researches carried out by the Swedish Academy of Engineering science indicate that a mixture of 30 p. c. arsenious oxide and 70 per cent. of Portland cement after suitable heat treatment gives an increased resistance to the action of sea water.

#### SOME NOTES ON BRIDGE DESIGN.

Pierson.

Brief notes of a general nature on girder design, and the pressure on the foundations of a bridge.

#### PRACTICAL TRIAL OF ROOFING SHEETS.

A paper was recently presented by Sir Robert Hadfield giving a brief account of a series of practical trials of roofing sheets of special steels being conducted at Sheffield. This abstract describes the trials briefly and sets forth the results observed so far. It was found that after 9 years exposure, painted sheets show no sign of failure. Amongst unpainted sheets, the copper steels are distinctly superior to ordinary steel. The zinc coating of sheets is worn off in about 5 years.

#### THE FRANKI PILING SYSTEM.

This system of piling has been introduced in India recently. It comprises the Franki concrete sheet pile and the Franki concrete bearing pile, both cast *in situ*. The procedure in both the cases is described in detail. A formula for determining the bearing power has been given.

#### NOVEL CONSTRUCTIONAL SYSTEM.

A new system of roofing called the "diagrid" system is described in this article. The design comprises essentially a diagonal system of beams or ribs which are arranged in two parallel sets equally spaced, intersecting each other at right angles, and rigidly connected at the intersection points. It can be carried out either in structural steel work or reinforced concrete. Bending moment is greatly reduced in this form of construction, and wide spans can be easily erected.

#### FOREST UTILISATION CONFERENCE.

The Inspector General of Forests, India, speaking at the Forest Utilization Conference held at Dehra Dun recently called attention to the value of timber in engineering construction. He mentioned the various activities of the Forest Research Institute in timber experiments and utilization of forest produce. Indian plywood has great possibilities. A certain type of timber has already secured a market in London. There is need for manufacturing companies to



take up the manufacture of these lines in India. Work has been done at the Institute on wooden electric transmission poles, houses, bridges, etc. The questions of preservation of wood, and the seasoning of timber have been investigated. A preservative called "Ascu" has been developed which has given very satisfactory results.

*No. 6—June 1937.*

## NOTES AND COMMENTS.

### IRRIGATION RESEARCH

Comments on the new method of design of weirs on sandy beds recently evolved in the Punjab, as a result of researches by Rai Bahadur Khosla and Dr. McKenzie-Taylor.

### HARDINGE BRIDGE.

Comments on the experiments at Khadakvasla with the models of the Ganges in connexion with the Hardinge Bridge at Sara.

## HOME AND ABROAD.

### NILE BARRAGE.

The new Mohamed Ali Barrage which is being built on the Nile north of Cairo will cost £2,250,000. 94 pairs of sluice gates and six power operated machines of special design to work the gates are to be built.

## RIVER IMPROVEMENT WORKS :

Lewis.

### MODERN MECHANICAL EQUIPMENT.

Describes some types of machines used in the present day in river work, excavation, embankment building, and dredging. The machines described include dragline excavators of various types, bucket excavators, and dredgers.

## LACEY'S FORMULAE—AN EXPLOSION.

Khushalam.

In this article an analysis is given, based on Lacey's formulae, with the object of finding the limits of discharge up to which determinate or real values for the dimensions of sections of channels could be obtained from Lacey's formulae. Both trapezoidal and elliptical sections are treated and it has been shown that for elliptical sections the limit for determinate dimensions of sections of channels works out to half of that obtained in the case of trapezoidal channels. The above finding is supported by actual conditions of large and small channels. In large channels only, the horizontal bed is perceived while all small channels assume an elliptical shape. From the

equations derived by the author, he has prepared a table of minimum values of discharge for various side slopes and silt factors. He has also obtained by analysis equations for limiting values of velocities for trapezoidal and elliptical sections. From these equations it is seen that the limiting velocities are independent of the silt factor. In conclusion the author points out that the results he has obtained are purely from theoretical considerations and have not been verified in actual practice.

#### THE JAMES RIVER BRIDGE.

Pierson.

A striking example of highway construction is a 16 mile Virginian road in America. The bridge over the James river on this road is the longest in the world being  $5\frac{1}{2}$  miles long. It has 447 short concrete spans each consisting of a concrete deck slab supported on steel I beam stringers resting on concrete piles. In addition to the short spans it has seventeen 90 ft. plate girder spans, eight 210 ft. through truss spans and a 300 ft. vertical lift truss span. Principal features of design and construction of the concrete deck and piles, the pier foundations, and the lift span are briefly outlined.

#### RESERVOIR SURVEYS.

Fergusson.

A new method developed by the author of contour surveying for reservoir projects in which the field work is considerably less than in the case of the usual method has been described in this article. The method obviates the running of lines of levels across the valley at right angles to the line of traverse. The theodolite alone is used and horizontal and vertical angles to the various points are measured. From these angles the distances of the points and their heights above the point of observation can be worked out by simple formulae or from graphs prepared from the formulae.

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## JOURNAL OF THE ASSOCIATION OF ENGINEERS (CALCUTTA).

VOL. XII.

No. 2—June 1936.

#### TUBE WELLS FOR WATER SUPPLY IRRIGATION.

Ghosh.

Tube wells have evolved gradually from the ancient standard well during the last 60 or 70 years. To-day there are instances of 24 in. diameter tube-wells, 1,000 ft. deep from which water is pumped out at the rate of 100,000 gallons per hour. The underground water supply is replenished by

rainfall, 30 p. c. of which goes to add to the underground reservoir. Geological features affecting underground supply are discussed. Some examples of artesian well water supplies in U. S. A., France, England, and Australia are quoted. The yield of a well depends on the velocity of the water passing through the sub-soil material without disturbing the finest sand. This velocity is called the critical velocity. In tube-wells this velocity is  $\frac{1}{2}$  in. per sec. The method of deciding a suitable spacing of tube wells in an area is described. Data of diameter, length of strainer, and discharge of some tube-wells in the Punjab are presented. A rough estimate for a water supply scheme to serve a town of 10,000 inhabitants has been given, and a scheme for irrigating an area of 1 sq. mile with costs has been worked out.

## SCIENCE AND CULTURE.

### VOL. II.

*No. 9—March 1937.*

Not yet received.

*No. 10—April 1937.*

## NOTES AND NEWS.

### IMPERIAL INSTITUTE OF SUGAR TECHNOLOGY.

The Imperial Institute of Sugar Technology at Cawnpore was declared open on March 11, 1937, by Sir Frank Noyce. The courses of study in the Institute are mentioned. A vast amount of research work will also be done at the Institute. The following researches are already in progress: treatment of factory effluents, cane drying, milling, methods of graining in pan boiling, and rapid and slow cooling in crystallizers. A scheme for investigating the possibilities of utilizing molasses for preparing cattle feed is also in hand.

### NATIONAL ACADEMY OF SCIENCES, INDIA.

A monthly meeting of the Academy was held at Lucknow on 2nd March 1937. The undermentioned papers were read, amongst others.

1. Nitrogen fixation and azotobacter count on the application of carbohydrates and other energy materials to the soil, by Prof. N. R. Dhar and Seshacharyulu. In this paper, the effect of sunlight on nitrogen fixation and azotobacter count on the application of sugars to the soil has been studied. In all experiments there is greater nitrogen fixation in the presence of sunlight but less azotobacter count in sunlight.

2. Changes in soil nitrogen after the addition of fresh cow dung to soil, by S. K. Mukerji. Fresh cow dung has been shown to fix atmospheric nitrogen in the presence of sunlight.

*No. 11—May 1937.*

There is nothing of interest to irrigation engineers in this issue.

*No. 12—June 1937.*

#### LONG RANGE FORECASTING OF THE SOUTH-WEST MONSOON AND EVEREST EXPEDITIONS.

Sen.

The prediction of the probable date of establishment and the prospects of the Monsoon about four months in advance is a scientific gamble when it is remembered that there are as yet no known rules for drawing up a long range forecast. The method of forecasting employed by the writer has achieved satisfactory results and is discussed in this article. The phenomena of the advance and retreat of the South-West Monsoon and the origin of the Monsoon are described in detail.

#### BREEDING FOR DISEASE RESISTANCE IN AGRICULTURAL PLANTS.

Burns.

Some aspects of breeding new strains of plants with a view to disease resistance are discussed in this article. Some recent instances of work with new strains resistant to the wilt disease in cotton and linseed are given. Investigations are in progress on the rust resistance of wheat all over India.

#### HYDRO-ELECTRIC PRACTICE IN INDIA.

A book with the above title written by Prof. B. C. Chatterjee of the Benares Hindu University is reviewed in this article. The publication is in two volumes of about 600 pages each and costs Rs. 50. If the consumption of electricity *per capita* is taken as a measure of civilization and prosperity, the position of India may be gauged from the fact that while the consumption of power per head in the more advanced countries amounts to 2,000 units, in India it is 6 units. The sources of water power in India are in an undeveloped condition. The available water power amounts to 2 million kilowatts of which barely 3 per cent. has been developed. Vol. I deals with the general principles of hydro-electric development, *viz.*, feasibility of a scheme

hydrology, elements of hydro-electric plant, power houses, turbines, regulating devices, etc. Vol. II deals with the descriptions of the various hydro-electric stations and sub-stations now operating in India.

## NOTES AND NEWS.

### INDIAN SCIENCE CONGRESS.

The Silver Jubilee Session of the Indian Science Congress will be held in Calcutta from January 3rd—9th, 1938. The various sections, with the names of the presidents are given.

### THE MADRAS ENGINEERING COLLEGE MAGAZINE.

VOL. V.

*No. 2—March 1937.*

#### ATTRITION TESTS ON STONES USED AS ROAD METAL IN INDIA.

Krishnan.

Attrition tests on road-making stones have been carried out in the engineering section of the Government Test House at Ali-pore, Calcutta, for the departments of Public Works of all the Provinces in India. The test is carried out by means of an apparatus called the Deval attrition testing machine. This article gives a description of the test as usually carried out and presents in tabular form results of tests on road building stones of the usual types met with in all Provinces. It is concluded that the best stones for road making purposes are the medium to fine grained compact basic rocks with more or less equiangular texture such as dolerite and basalt. Soft rocks like limestones, shales, and weaker types of sandstone are not suitable for any but light traffic.

#### DESIGN OF REINFORCED CONCRETE ARCH BRIDGES.

Lakshmana Rao.

This article presents a procedure for designing reinforced concrete arches. The fundamental theory of the arch rib is discussed and the advantages of arches over straight beams are enumerated. The differences between a 3 hinged, 2 hinged, and hingeless arch are summarized. The hingeless arch is considered to be the best. Principles of design of a hingeless arch are then set forth. Three fundamental equations are derived based on the elastic theory. Other relationships are obtained from the three fundamental equations, and the arch can be designed with the help of these relationships.

## THE MALAYAN AGRICULTURAL JOURNAL.

VOL. XXIV.

*No. 9—September 1936.*

AN ACCOUNT OF IRRIGATION AND DRAINAGE CON-  
TROL ON AN AREA OF DWARF COCONUTS.

Wardlaw.  
Mason.

An account is given of a method of irrigating coconut areas and controlling drainage in order to facilitate the free movement of subsoil water, one of the conditions favourable to the growth of coconuts. Two main channels, one irrigation and the other drainage, are cut along two longer sides of a rectangular block and also small alternating irrigation and drainage channels in the block of land itself. The level in the main drainage channel is kept below the irrigation channel. This difference in water levels causes a steady flow of soil water from the irrigation to the drainage canal through the alternating channels.

## REVISTA DE LA SOCIEDAD CUBANA DE INGENIEROS.

(In Spanish).

VOL. XXIX.

*No. 6—December 1936.*

VOL. XXX.

*No. 3—March 1937.**No. 4—April 1937.**No. 5—May 1937.*

There is nothing of interest to irrigation engineers in these issues.

## IRRIGACION EN MEXICO.

(Revista Mensual).

(In Spanish).

VOL. XIII.

*Nos. 5 & 6—November & December 1936.*

EXAMINATION AND INSTRUCTIONS FOR THE CONTROL  
OF SOIL AND ITS CONSOLIDATION FOR THE CON-  
STRUCTION OF EARTHEN DAMS.

Barona.

A detailed article on the subject.

## CHEMICAL ABSTRACTS (WASHINGTON, U. S. A.).

VOL. 30.

*No. 11—June 10, 1936.*

The Section dealing with Soils, Fertilizers and Agricultural Poisons mentions the following articles among others :—

1. A comparative study of the black earths of Australia, and the regur of India.
2. The infiltration and evaporation of water in the soil.
3. Soil Nitrogen.
4. Liming of soils.

The cement and other building materials Section mentions the following literature amongst others :—

1. Corrosion of cement.
2. Light-weight composition shingles.

## ELECTRICAL NEWS AND ENGINEERING.

VOL. 45.

*No. 21—November 1, 1936.*

BOULDER DAM. ITS SALIENT FEATURES.

Titus.

The principal features of the Boulder Dam Project are described, with special reference to the power developing part of the scheme. The Project provides for development of 1,800,000 H. P. in two power houses. The power generating units are described.

## CURRENT FARM ECONOMICS (OKLAHOMA).

*Series 49.*

VOL. 10.

*No. 1—February 1937.*

Deals with prices of farm products and other aspects of economic problems in U. S. A., with particular reference to Oklahoma.

## CIVIL ENGINEERING (NEW YORK).

VOL. 6.

No. 6—June 1936.

## THE FUNCTION AND DESIGN OF CHECK DAMS.

Baumann.

Soil erosion control is an essential element of flood control. Erosion precludes the growth of vegetation and results in increase of run-off and floods. The check dams system constitutes the first line of defence against erosion. They hold back the flow temporarily, causing the deposition of material carried by the water. The stream bed is thus raised and the side slopes are flattened. This causes a decrease in velocity and scouring action. Check dams provide no direct protection against major floods. Their effect is indirect in that they stabilize the soil and promote the growth of vegetation which reduces the run-off. Rules useful in the design of check dams based on twenty years' experience in the San Gabriel mountains and in the Alpo have been given. The writer considers that to build a check dam system absolutely immune to onslaughts from landslides, boulders and mud avalanches produced by cloudbursts is impossible. "Engineers may well remember what the French philosopher and mathematician, Pascal, said almost three hundred years ago. He said that two natural phenomena would never be quite understood by men—women and water."

## SAFETY FACTORS IN HIGHWAY DESIGN.

Rader.

Frequency of road accidents makes it imperative that in modern road design attention should be paid to provide every requirement for safe operation of high speed traffic. This article describes some of the features in design to ensure safety such as adequate width and number of traffic lanes, increased sight distances, reduction of curvature and grades, better designed railroad and highway crossings provision of footwalks, and use of intensive lighting.

## CURRENT PERIODICAL LITERATURE.

## DAMS.

*Technique Moderne, April 1935.*—Discussion of theory of weirs and low dams on permeable ground. Laws of movement of water through pervious formations. Review of model experiments.



ACTIVITIES OF THE NATIONAL WATER RESOURCES  
COMMITTEE.

A symposium containing abstracts of articles presented at the annual meeting of the American Society of Civil Engineers on January 20, 1937. The following articles are included:—

1. RESUME OF THE DRAINAGE BASIN STUDY REPORT. Wolman.

This article reviews the report of the Water Resources Committee. The Committee was requested to determine the principal water problems in the various drainage areas of the country and to outline in broad terms a unified plan of water development and control designed to solve those problems. It was also requested to recommend specific projects as part of the unified plan. The Committee has released the drainage basin study report. The report defines the characteristics of a sound water policy, stresses the urgent need for developing basic hydrologic data now lacking, recommends quantitative studies of the effect of vegetable cover and soil erosion upon hydrologic phenomena and recommends investigations of coastal erosion phenomena and the effect of beach protection works. Regional power market surveys are also considered necessary for an orderly development of streams. The report includes more than 7,000 proposed projects.

2. THE NATIONAL DRAINAGE BASIN STUDY. Fowler.

This article describes the study in general and calls attention to the need for further investigation.

3. WATER PLAN FOR THE RED RIVER OF THE NORTH. Horner.

This article describes the formation of an interstate Committee on "Water plan for the Red River of the north" and the work carried out by the Committee. The major problem of the area is the conservation of flood water and its release and transportation in stream beds, and a co-ordinated water plan was drawn up by the Committee based on this problem. The plan provides for construction of reservoirs, and improvement of stream channels.

4. THE RIO GRANDE JOINT INVESTIGATION. Barrows.

This article describes a joint investigation of the water resources of the Rio Grande Basin by an interstate Commission, and the National Resources Committee.

**5. COLLECTING AND PUBLISHING HYDROLOGIC DATA.****Saville.**

This article is a review of the report of the special advisory committee on hydrologic data appointed by the Water Resources Committee. This special committee undertook to set forth standards for the collection and publication of hydrologic data. The recommendations made by the Committee are given.

**SOME RECENT HIGHWAY DEVELOPMENTS.**

This is a symposium on recent developments in the highway field consisting of abstracts of three papers delivered before the annual meeting of the American Society of Civil Engineers on January 21, 1937. The papers are :—

**1. STATE-WIDE HIGH PLANNING SURVEYS.****Fairbank.**

Extensive planning surveys with Federal funds have been undertaken by forty States. The surveys include an inventory of road details and structures, study of traffic as to character and flow, weight and commodity surveys, financial compilations, and studies of road life.

**2. HENRY HUDSON PARKWAY AND ITS TRAFFIC.****Downer.**

Describes an important road recently constructed.

**3. RURAL ZONING AND HIGHWAY IMPROVEMENT.****Carmalt.**

This article discusses various ways of roadside improvement in rural areas.

**A STEEL-PILE PIER IN TROPICAL OCEAN WATER.**

Among the more important design features are the omission of underwater bracing, provision in the design for earthquake stresses, and the use of gunite concrete over the entire immersed lengths of piles before driving, to guard against damage by destructive marine growth.

**REPORTS OF RESEARCH COMMITTEES.**

This article discusses various ways of roadside improvement in 1934 and its principal activity is the general advancement of knowledge in the field of hydraulic research, with emphasis on open channel hydraulics and model tests. The investigations of the Committee include :—

1. Tests on full sized structures to verify results of previous hydraulic model tests. Facilities for comparing prototype behaviour with previous model performance are being installed in works under construction.
2. Investigation of problems on fundamental research. Five problems are being studied, which are : travelling waves on steep slopes ; curves in open channels ; phenomena in intersecting streams ; the conversion of kinetic to potential energy ; sedimentation at the confluence of rivers.

The committee is preparing an up-to-date manual of hydraulic laboratory practice to aid in securing greater uniformity in the method of approach to the solutions of practical problems by model studies.

The committee is co-operating in a project intended to secure English translations of important papers on hydraulics appearing in other languages. A set of letter symbols for use in hydraulic laboratories has been tentatively adopted by the Committee. (See page 76 of Quarterly Bulletin No. 5).

#### ENGINEERS' NOTEBOOK.

##### ELIMINATING TRIAL AND ERROR IN BACKWATER COMPUTATIONS.

Irwin.

Describes a graphical method of computing backwater profiles based on Manning's formula. This method eliminates trial and error and is quick and accurate.

##### DISCHARGE AREA OF CIRCULAR GATES.

Nelidov.

Gives a method of computing area of a circular gate at partial openings by a graphical method.

##### DESIGNING STABLE CHANNELS AND COMPUTING BED-LOAD MOVEMENT.

Hedberg.

Since 1932 Prof. Meyer-Peter and his associates have been conducting studies of the movement of bed load materials in the University of Zurich, Switzerland. Two papers have been published giving a description of the experiments and proposals for the utility of their findings. The present article is a review of these papers. Prof. Meyer-Peter has formulated an equation connecting discharge per unit width, friction slope, diameter of bed load material, and quantity of transported material per unit width. The limitations to the uses of this equation are discussed. In a typical case where bed load movement does not take place, the Meyer-Peter equation used in conjunction with Manning's or Kutter's formula provides a complete solution for the design of a stable channel of any shape. This has been illustrated by working out an actual problem. In their second paper, Prof. Meyer-Peter and his associates explain the use of the equation for calculating bed loads in natural streams and for designing the regulation of such streams. The points that arise in practice in this use of the equation are discussed and the writer concludes by saying that although the theory is well substantiated in the laboratory there is an urgent need for verification from nature.

## CURRENT PERIODICAL LITERATURE.

## DAMS.

Concrete Arch Dam, Buchanan, Texas. *Compressed Air Magazine*, Nov. 1936. Plan and construction operations of L shaped multiple arch dam 11,200 ft. long on the Colorado river, consisting of 29 reinforced concrete arches of 70 ft. span and maximum height of 160 ft. are described.

Seepage and uplift under dams. *Military Engineer*, Sept. Oct. 1936. Describes determination of gradients beneath structure, method of obtaining flow and pressure lines, seepage through silt, sand and gravel, relation of gradient to foundation failure, and determination of uplift pressure.

## FOUNDATIONS.

Underpinning and foundation work in loose and waterlogged ground by chemical consolidation, ground-water lowering and other means. *Structural Engineer*, June 1935. Describes British experience with Joosten chemical process of consolidation, and ground water lowering etc.

No. 4—April 1937.

## PLANNED UTILIZATION OF WATER RESOURCES.

Morgan.

Abstract from a paper read at the Third World Power Conference held in Washington in September 1936. Most of the earlier water control projects in the United States have aimed at control for particular usage. In recent years however, the aim has been to secure the greatest public benefits for all purposes. It has come to be recognized that the many uses of water are inter-related, and an adequate system of planned utilization of water resources is essential. The writer then proceeds to review the more or less spontaneous growth of water developments in the U. S. A. and the results achieved. The development of Mississippi river for navigation and flood control is discussed. Control of Mississippi has suffered from two types of extremist views. One of these is that levees are the only means of control, and the other view strongly supports reservoirs in the headwaters as the most effective means of control. The conflict in the two views has been a great handicap in the development of effective flood control. There are other instances where comprehensive planning has achieved very successful results such as the Miami Conservancy District.

Power and Irrigation development are essential elements of some of the new expensive projects. The irrigation project furnishes the basic market for power output and the revenue from power covers a large part of the irrigation cost. Domestic water supply from surface water is closely related

with flood control, forest cover soil erosion and regulation of river flow. In previous years, development of power sites was considered a single purpose undertaking. With the rapid improvement of steam power development during the past decade, the economy and flexibility of steam power is a challenge to hydro-electric power. When sites are developed for a variety of purposes it might be possible to produce power at a cheaper cost.

Comprehensive legislation, both Federal and State is needed for the integrated development and utilization of water resources in U. S. A. The essentials of such legislation are discussed. The work of the Tennessee Valley Authority is then described as an example of planning for the unified control of a great river system. (See Quarterly Bulletin No. 3, page 90).

#### GEOPHYSICAL METHODS AND CONSTRUCTION WORK.

Stipe.

The application of geophysical methods to civil engineering for determining the nature of underground formations is of recent origin. Some general methods employed are briefly described. In the magnetic method, modified compasses are used for measuring distortions in the earth's magnetic field caused by the varying magnetic permeabilities of the underlying rock formations. In the gravitational method, sensitive torsion balances are used to detect variation in gravitational pulls which result from differing densities of the underlying rocks. In the Seismic method, the time required for vibrations set up by artificial means such as explosives at a known distance underground to travel to the earth's surface is an index of the nature and depth of the formations. The time taken varies with the elasticity of the formations through which the vibrations are transmitted. A seismograph is used to detect the vibrations reaching the surface. The electrical method has proved the most useful and dependable in civil engineering work. This method depends on the fact that the various materials of the earth's crust offer different degrees of resistance to the flow of an electric current. An electric current is passed through the ground, and the strength of the ground current is measured at various points. The power source and measuring circuits are connected to the ground by means of short metal plugs driven a few feet inside the earth.

A few actual cases where these methods were used and the results obtained are given. These include dam sites, harbour survey, determination of water bearing horizons, and in highway work.

**MAP MAKERS AND MAP USERS.**

Bowie.

The author says that with the growing population of the United States, the increasing importance of the need for conservation of natural resources is apparent. Accurate maps are necessary for the surveys of these resources. A national mapping programme should be pushed forward. The author then proceeds to outline modern procedure in map making including aerial photography, and concludes with a description of the national control surveys and uses of control survey data.

**THE MENAI SUSPENSION BRIDGE AND OTHER BRIDGES**  
**DESIGNED AND CONSTRUCTED BY THOMAS TELFORD.**

**Baker.**  
 Amritage.

The Menai Bridge was completed by Telford in 1826 and was a unique piece of work. The suspension span is 580 ft. The towers are 153 ft. above high water level and the bridge has a clearance of 100 ft. above high water. The roadway is 28 ft. wide and the chain system consists of 4 groups of chains, each group consisting of 4 chains of wrought iron links 1 in. thick and  $3\frac{1}{4}$  in. deep. The anchorages and their construction are described. A smaller bridge, also of the suspension type, built by Telford called the Conway Bridge is also described. Experiments carried out by Telford to determine the transverse load which could be suspended from a stretched wire are described. Telford was the first President of the Institution of Civil Engineers.

**MOVEMENT OF BOULDER DAM DUE TO GROUTING.**

Simonds.

Boulder Dam consists of a large number of vertical columns separated by vertical joints which were subsequently grouted to combine the columns into a monolithic structure. In this article a description is given of how measurements were made of the block deflexions caused by grouting the vertical joints. Blocks of a dam are designed for stability under water pressure but they may not be stable under a high grout pressure in the contraction joints. The apparatus used in measuring the change in width of joints is described. A description of the cooling system consisting of pipes embedded in the body of the dam in order to dissipate the heat liberated by the setting concrete is also included. •

**ENGINEERS' NOTEBOOK.**

**ARTIFICIAL VIBRATION—A NEW METHOD OF**  
**DYNAMIC RESEARCH.**

Bernhard.

A new method of testing structures by inducing artificial vibration in them is described herein. It is claimed that the method is very useful in making studies of earthquake forces.

## SOCIETY (AMERICAN SOCIETY OF CIVIL ENGINEERS) AFFAIRS.

### COMMITTEE ON FLOOD CONTROL.

By authorization of the Board of Direction of the Society, a Committee on flood control has been appointed to make a general appraisal of flood control methods with particular reference to their physical and economic limitations.

### CURRENT PERIODICAL LITERATURE

#### DAMS.

*Western Construction News Vol. II, No. 9, Sept. 1936.* Description of the repairing of Lake Pleasant multiple arch dam in Arizona which is 2,000 ft. long and 250 ft. high, by filling buttresses with concrete, adding heavily reinforced cross wall along upstream face of buttresses, and adding a series of horizontal floors at various elevations.

#### FOUNDATIONS.

*Western Soc. of Engrs. J., Vol. 41, No. 4, Aug. 1936.* Description of shoring and underpinning for foundation failures, and procedure for deep underground construction; also emergency shoring and building moving.

*No. 5—May 1937.*

### THE FLOOD OF 1937 IN THE OHIO VALLEY.

Horn.

The causes of the recent flood in the Ohio are discussed, and the 1937 flood is compared with previous floods on record. The 1937 flood is attributed to excessive rainfall in the Ohio valley, particularly in the lower reaches. Engineering operations during the flood consisted of safeguarding existing navigation works, collection of data as regards rainfall and flood heights reached, and the relief operations. These are briefly described. The author is of opinion that a flood greater than the 1937 flood can occur in the Ohio valley. In planning flood control measures, allowance should be made for a 'superflood' providing conditions more unfavourable than the 1937 flood which itself constituted a record.

A system of 88 reservoirs located on tributaries of the Ohio river has been recommended for flood control. The author believes that a reservoir system alone cannot be counted upon to give complete protection from major floods. The effect of the reservoirs decreases as the mouth of the main river is approached. A flood control scheme must be so designed as to be capable of development into a more elaborate system later on and should easily lend itself to operation under varying flood conditions.

**GEOLOGY OF DAM SITES IN HARD ROCK.**

Mead.

Paper presented before the Second Congress on Large Dams at Washington in September 1936. In planning a dam, a knowledge of the geological features of the site is indispensable to the hydraulic engineer. Information on the geological nature of the foundations is obtained usually by core boring and core drilling, churn drilling, wash boring and geophysical prospecting. Physical properties of different types of rock such as igneous and metamorphic, sandstone, and limestone which are of importance to the engineer are discussed in relation to dam foundations.

**PRINCIPLES OF SOIL STABILIZATION.**

Housel.

"Soil stabilization may be defined as any process of treating a soil mixture to improve its ability to resist deformation under load and to ensure durability of the desirable state produced". The properties of soil mixtures which are important factors in soil stabilization are discussed, particularly as applied to sub-grades. The soil stabilization methods developed up to the present time are described. These are: mechanical compaction at optimum moisture content, proportioning of soil mixtures, and use of chemicals to supply cohesion to the granular mass of soil.

**ECONOMIC JUSTIFICATION FOR FLOOD PROTECTION.**

White.

Methods for determining whether flood control works are justified on economic grounds are discussed in this article. Typical methods of calculating benefits and costs are given. Deficiencies in the present technique of estimating the economic justification of flood control projects are discussed.

**ENGINEERS' NOTEBOOK.****DISCHARGE OVER A FREE FALL.**

Langbein.

The author reviews some of the more important formulae in force for calculating discharge over a free fall. These formulae are applicable under special conditions, such as parallel flow at critical depth in the approach channel. In actual practice, approach channels with steep gradients and velocities above the critical are frequently met with. The author suggests a more general approach in the solution of the problem, and has evolved a formula which is generally applicable under all conditions.

**ADDITIONAL SOLUTION FOR BACKWATER FORMULA.**

Mr. Goodwin presents an alternative graphical method of solution of Manning's backwater formula. (See issue of "Civil Engineering" dated March 1937 in this Bulletin).



## CURRENT PERIODICAL LITERATURE.

Bridges : Piers, Foundations. *Bauingenieur* Oct. 2, 1936. Gives geological methods and tests for determining dependability of underlying strata and methods of improving them for ensuring adequate supports for caissons.

Dams : Concrete Arch dam in Algeria. *Technique Moderne* Jan. 1, 1937. Describes a reinforced concrete multiple arch dam 46 m high and 260 m long. Concrete mix, vibration of concrete, construction of cut-off, are also described.

## EDISON ELECTRIC INSTITUTE BULLETIN.

VOL. V.

No. 1—January 1937.

THE PLACE OF THE ELECTRIC WATER SYSTEM IN A  
RURAL ELECTRIFICATION PROGRAM.

Rice.

The programme of rural electrification in America has progressed only so far as to pay for the bare cost of service only. The chief problem now is of increasing the use of the service so as to secure better revenue returns. This can be achieved by extending the use of the various equipment and appliances available to render the greatest service to customers. In this article the writer has analysed one such equipment namely the electric water system in rural areas in order to determine its revenue possibilities. He discusses the basic need for such equipment, the interest of the farmers in it and the immediate revenue possibilities to the power company. The potential revenue possibilities are considered and it is suggested that the desire to instal electric water system installations in rural areas should be created by a systematic advertisement campaign.

## ENGINEERING NEWS-RECORD.

VOL 118.

No. 9—March 4, 1937.

WHY DESILTING WORKS FOR THE ALL-AMERICAN  
CANAL?

Vetter.

The All-American Canal takes off the Colorado river at a point 300 miles below Boulder Dam site. Special desilting works designed to remove 70,000 tons of silt per day have been built at the head of the All-American Canal. In view of the fact that the Boulder Dam will arrest all the silt coming down the river, the necessity of desilting

works at the head of the All-American Canal has often been questioned. In this article the author explains the necessity of the desilting works. Observations of the retrogression of river bed below Boulder Dam are taken regularly and these observations show that the clear water discharged below Boulder Dam picks up material from the river and causes retrogression below the dam. Imperial Dam at the head of the All-American Canal and Parker Dam, midway between Boulder and Imperial Dam, will reach completion at about the same time. The silt charge picked up by the river between Boulder and Parker Dams will be arrested at the reservoir formed by the Parker Dam. The clear water issuing below Parker Dam will pick up fresh material from the river bed till the stream becomes saturated with silt. This silt will first of all be deposited in the reservoir formed by the Imperial Dam, and within a relatively short period of time the accumulated silt may be expected to reach the sills of the headgates of the canal, after which it will enter the canal. To prevent this entry of silt into the canal, desilting works were necessary.

#### PILE PULLING AND RE-USE CUTS COFFERDAM COST.

This article describes the procedure of pulling out piles from one Cofferdam after work is finished and using them again in another. This procedure has been adopted with success at the Pickwick Landing Dam.

#### PROTECTING NORTH CAROLINA BEACHES AGAINST WIND AND WAVE EROSION.

Abstract of a paper presented before the American shore and beach preservation Association. To combat severe erosion on the windswept and treeless beaches of North Carolina, protective works are being carried out on 175 miles of the coast. The method of protection adopted is the creation of sand dunes which could be held in place by planting protective covering of grasses, and native trees. Brush fences helped the formation of the dunes. The fences consist of light brush panels 7 ft. long held together by battens at top and bottom and erected on posts driven into the sand. A single fence will cause the formation of a dune 20 ft. wide at the base, and by successive erection of additional fences on top of this dune and by placing the new fences on alternate sides of the original fence a height of 25 ft. and a base width of 150 ft. has been achieved.

## DESIGN MODERNIZATION AND CEMENTS DOMINATE CONCRETE MEETING.

This is a brief report of the thirty-third annual convention of the American Concrete Institute, held in New York from February 23-26, 1937. The convention was opened by two papers on European practice. Europe excels in bridges and the United States in dams. Manufacturing technique in Europe is behind that in America but nothing to compare with Freyssinet's 'treated concrete' is seen in America. This eminent French engineer has made piles and pipes using vibration, pressure to stretch reinforcements, high temperature curing and pre-stressing. A series of papers on cement studies in which the most animated discussion centered on the Portland-puzzolan cements were presented. As a result of studies of concrete materials for the Passamaquoddy tidal power project it was found that Portland cements of medium high fineness and low calcium aluminate gave excellent strengths, were resistant to magnesium sulphate attack and had low volume change under freezing and thawing. Portland cements with high calcium aluminate could not withstand sulphate attack.

In a paper on the cement used in the spillway of Bonneville dam, experience with Portland-puzzolan cement has been discussed. This cement produces a very satisfactory concrete. Three papers cover the subject of concrete maintenance and repair. One of the papers describes the work of relining a canal on the Uncompahgre irrigation project in Western Colorado. Vibration studies of pavement concrete are presented in one of the most significant papers of the convention. Several design papers of note describing the foundation features and work on San Francisco Bay Bridge, structure of New York World Fair, and the Palace of the Soviets in Moscow were also presented. The Joint Committee on concrete and reinforced concrete presented its progress report which was discussed.

## LETTERS TO THE EDITOR.

Prof. Vierendeel in a letter to the editor says that the invention of the Vierendeel truss bridge dates back to 40 years when this type of bridge was first built in Belgium. During these forty years a hundred such bridges ranging from 100 ft. to 300 ft. in span have been built in Belgium, and the Belgian Congo. In this long period the system has been perfected from the technical and constructional

standpoint. These bridges are twenty per cent. cheaper than the triangulated truss bridges. With Prof. Vierendeel's method, a Vierendeel truss of any type can be designed in one week without any trouble.

The Chief Forester of the Tennessee Valley Authority in a letter to the editor comments on an article 'River and Region' published in the Engineering News-Record dated December 24, 1936. He says that the problems of handling land now covered by forest, and stopping erosion in non-agricultural land are distinct from each other and were not represented as such in the original article. The forestry division of the Tennessee Valley Authority is engaged in the preservation and adequate development of the existing forest area. Attempt is also being made to stop gully erosion. Formerly the method in use was to build a large number of small check dams but the inadequacy of this method was soon realized and the present method is to construct diversion ditches to carry water at low gradients away from the upper end of gullies, and paved water channels to carry this water down to the stream beds below. Soil erosion prevention and control is a vegetative problem and the work done is meant to hold the soil long enough to let the vegetation establish itself. Forest land management as practised by the department is outlined in the concluding portion of the letter.

*No. 10—March 11, 1937.*

SAFEGUARDING SCHOOLS AGAINST EARTHQUAKES.  
REPAIRING EARTHQUAKE DAMAGE.

Nibecker.  
Byers.

These are the first two of a series of three articles on rehabilitation and rebuilding of schools in Los Angeles, California following the disastrous earthquake of 1933. In all cases of construction of new buildings and repairs to old ones special methods were employed to make the buildings resistant to earthquakes. The first article is a general discussion of the problem of safeguarding schools with which the public of Los Angeles were faced. The second article sets forth the five schemes of rehabilitation, describing the actual construction employed under each scheme in outline.

LARGE SEWER ON OCEAN BOTTOM HAS JOINTS OF  
NOVEL DESIGN.

The article describes an outfall sewer of 5 ft. inside diameter under construction in Los Angeles. A type of metal

joint for concrete pipes is being used without going to the expense of an all-metal pipe, and the design is believed to be free from joint leakage and breakage. The use of pontoons for placing several sections at a time, arrangement of details to facilitate submarine construction, and variation of joint design to suit depth and bottom conditions are described, as also for construction operations.

### THE RIVER'S RIGHTS.

The Editor in commenting on the floods in the Ohio Valley says that man's error has not been the neglect of flood control measures but his refusal to recognize the right of rivers to their floodways. There is little excuse for the water front location of thousands of properties damaged in the recent floods. Travelling down the Ohio during the recent flood, one could see scores of farm homes completely inundated though standing only a stone's throw from high ground. The federal government has never seen fit to establish flood flow boundaries for its rivers. People and Industries have been permitted to occupy normal flood channels, and flowageways have been restricted by filling in and by commercial development without protest by federal government. "In planning flood relief let us remember that the river has rights, and these rights must be respected." †

### CURRENT NEWS.

Voluntary removal to higher ground of those sections of Ohio Valley communities most subject to flood will be facilitated by a programme recently announced according to which government agencies will advance rehabilitation loans to the communities concerned.

In answer to claims made by the Jefferson County Grand Jury, the Chief of Engineers, U. S. Army has issued a statement denying that the navigation dams in the Ohio River had any effect on the height of the recent flood in Ohio. The Grand Jury held that the flood was caused by the dams in the Ohio River which have raised the bed of the river by several feet. The Chief of Engineers points out that the dams are constructed of shutters that are lowered flat on the bottom when the river rises. They have caused no deposit of silt because when the river carries silt to any considerable extent, the dams are down. The recent disastrous floods were solely due to an extended period of heavy rainfall.

No. 11—March 18, 1937.

# SEMINOE DAM.

## I—SITE EXPLORATION AND DESIGN STUDIES.

Keener.

## II—CONSTRUCTION PLANT FOR SEMINOE DAM.

Peugh.

This dam is being built on the North Platte River in Wyoming, U. S. A., for the Casper Alcova Irrigation Project, and generation of power. It will store water which will be let out into the river and will be diverted by the Alcova Dam for Irrigation. The first of the two articles describes the geological conditions of the site and the principal features of the dam. The dam is to be a concrete dam of the arched type. The crown section is 261 ft. high, 15 ft. wide at crest, and 85 ft. wide at the base. The upstream face is vertical and the downstream face has a batter of 0.268 to 1. The upstream face is laid out on a constant radius of 290 ft. and on the downstream side, the radii decrease progressively towards the abutments so that the horizontal section becomes wider as the abutments are approached.

Artificial cooling will be employed to reduce the temperature of concrete while setting. A grout curtain will be constructed in the foundation rock below the heel of the dam. A tunnel spillway through the right abutment of the dam is proposed. The tunnel will be 30 ft. in diameter and concrete lined throughout. The tunnel inlet will be controlled by electrically operated stoney gates. Release of water for irrigation down the river will be effected by two 72 inch welded steel pipes embedded near the centre of the dam.

The second article describes the construction plant in use. An aerial tramway  $2\frac{1}{2}$  miles long brings aggregate to the site from the quarry. Bulk cement is supplied and stored in Silos whence it is brought to the mixing plant by tramways. Concrete is placed by means of cableways.

## CONTROL OF GREAT FLOODS.

Morgan.

In this article, the Chairman of the Tennessee Valley Authority gives his views on flood control. He advocates examination of every possible method of solution of the problem of flood control including those which seem to offer very little promise. In a large flood control project, a single type of construction will rarely offer a solution. Floods cannot be mastered by levees alone or reservoirs alone, a combination of the two is most effective. Procuring of basic data of rainfall, run-off, stream capacities, storage areas, foundations etc. is of vital importance in flood

control projects. Soil management, forestry, and reservoirs on headwater streams should not be ignored as means of flood control. An integrated system of river control for all purposes such as power, irrigation, flood prevention, navigation etc., is essential.

#### EXTERIOR WALLS OF CONCRETE HOUSE COMPLETED IN ONE DAY.

Use of a vacuum process by which excess water is speedily forced out of freshly poured concrete permits quick removal of forms followed by application of a stucco surface before final setting. This was demonstrated recently in Maryland, U. S. A., where the exterior walls of a bungalow 27 ft. by 37 ft. consisting of two 3 inch slabs separated by a 6 inch. air space were completed in one working day. The operations are described in detail.

#### PRACTICAL SOIL MECHANICS FOR SMALL DAMS.

Doggett.

"In building some 30 small earth dams since 1928, the Indiana Department of Conservation has passed through an evolution in design and construction to practice representing the latest development of science in the disposition of materials, and in fill compaction. In their application to very small dam building these processes have a special interest, and an outline of practice is given here with a brief account of the character and purpose of these water conservation projects."

#### HOT WEATHER CONCRETING.

Work at the Imperial Dam on the Colorado River above low water level is ordinarily suspended between June 1, and October 1, owing to the extreme heat. The temperature in the shade often reaches 118°. By the use of certain simple expedients, concreting has been carried on safely under temperatures which would have made concreting impracticable otherwise. On this job a deep well supplies water at 70°F. for mixing during the hot weather. The aggregate bin is surrounded with a burlap covering on which water sprinkles continually. The mixer and the concrete delivery pipe are precooled by the same method.

#### EARTHQUAKE-RESISTANT DESIGN FOR NEW SCHOOL BUILDINGS.

Bolin.

This article gives methods and details used in the new school buildings of wood, steel, concrete, and brick in accordance with California's structural law of 1933, the "Safety of School Houses Act" formulated after the disastrous earthquake.

**EDITORIAL.****FLOOD PROTECTION AND THE MISSISSIPPI.**

The Editor comments on the Mississippi Flood Control Project. He says that the Jadwin Plan of flood control limits the possible flood volume which has been demonstrated to be too small. The project is inadequate and requires a searching review. It is based on rejection of conservation and storage and must be revised.

*No. 12—March 25, 1937.*

**DAY-LABOR STREET PAVING.**

Campbell.

Minneapolis, a city of nearly half a million inhabitants is carrying out all city construction work with its own engineering and construction forces and equipment, for the last 35 years. During this period an efficient system of paving organization, plant and technique of design and construction, has been developed, which is described herein.

**ECONOMIC SIZES OF PRESSURE CONDUITS.**

Hinds.

This article sets forth methods of determining the most economical size of pressure lines. The procedure was developed in the design of the Colorado River Aqueduct which includes many syphons and force mains.

**WELLS FOR THE WATER OF HAWAII.**

Stearns.

In Oahu, which is the third largest of the Hawaiian Islands, the principal source of water is artesian groundwater supply. This supply has been endangered by sea water contamination. A new type of well construction is being used now to minimize salt water contamination and permit increased development of the artesian basins. This method utilizes the artesian basin supply by skimming fresh water off the underlying layer of heavier sea water. The well consists of an inclined shaft from the ground surface to the water table level where one or more infiltration tunnels are extended horizontally at the zone of saturation. Pumps are used to elevate the water from the tunnels to the surface.

*No. 13—April 1, 1937.*

**PAVEMENT DESIGN AND CONSTRUCTION IN MINNEAPOLIS**

Campbell.

This article is supplementary to the article entitled "Day-Labor Street Paving" in the previous issue and describes technique of construction and maintenance operations.



**DRAINAGE BASIN PROBLEMS AND PROGRAMS.****Wolman.**

This is a summary of the drainage basin report of the Water Resources Committee outlining its principal features, limitations, and recommendations. The objectives of the committee are to determine the water problems, to outline the pattern of development and control which would solve the problems, and to suggest projects. Estimated costs of proposed projects are given in a table. The recommendations on major projects are outlined in brief. The committee's next endeavour will be to extend the investigation. (See also issue of the journal dated 15th April 1937, in this Bulletin.)

**DETERMINING EVAPORATION LOSSES FROM WEATHER BUREAU DATA.****Meyer.****Levens.**

Intelligent planning for water conservation demands consideration of evaporation losses. Mr. Meyer first published in 1915 a formula for computing evaporation. After considerable experience in this field of hydrology he has now derived some new coefficients for use in his formula. The formula has been verified by some independent investigations. A chart has been prepared based on this formula, from which the evaporation can be read off.

**EXPERIENCE WITH LIGHT AGGREGATE IN CONCRETE CONSTRUCTION.****McLean.**

Light weight aggregate was used exclusively except for foundation piles in a two storey commerce building in California. The foundation conditions were poor and it was necessary to lighten the deal load by using light weight aggregate. The aggregate was made from a low grade diatomaceous earth containing a small amount of clay. Grading of aggregate mixing concrete, and placing are described. Results of compression tests are tabulated. Costs of light weight aggregate and ordinary concrete are compared.

*No. 14—April 8, 1937.***LARGE CONCRETE SHELL ROOF COVERS ICE ARENA.****Tedesko.**

Describes a thin concrete shell roof  $3\frac{1}{2}$  in. thick supported by two-hinged arches for a skating floor 340 ft. long and 232 ft. wide. Details of design and reinforcements are given and the construction procedure is described.

**WHEN EXTRAS ARE ALLOWABLE AND HOW TO GET THEM.****King.**

"Few questions in engineering construction have led to more frequent dispute than claims and allowances for extra

work. In many actions at law to which these disputes have come, the courts have handed down decisions of utmost importance to contractors”.

In construction work alterations and additions are almost certain to be required during the progress of the work. The procedure to be considered in handling such changes in mutual justice is the subject of this article. A number of typical illustrative cases of dispute and the decisions thereon are given. Other points of dispute which are likely to arise are discussed in detail and decisions are recommended. After reviewing the question from all possible angles, the writer who is an attorney, has drawn up a number of rules for claiming extras which should prove useful to contractors.

#### MODERNIZING AN OLD CONCRETE ROAD WITH MAXIMUM SALVAGE.

Saville.

Two recent resurfacing operations by the Missouri State Highway Department are described in this article as examples of modern road treatment. One operation was Portland cement concrete resurfacing and the other was asphaltic concrete resurfacing. The original pavement was a Portland cement slab badly broken.

#### WIDENING AN ANCIENT STONE BRIDGE FOR MODERN TRAFFIC.

Iena Bridge in Paris is 122 years old. This is a stone arch bridge 49 ft. wide. Recently, its width has been increased to 95 ft. The new wider bridge has been obtained by building new reinforced concrete arches on entirely separate foundations on each side of the arches of the existing bridge, and spanning the spaces in between with steel floor beams.

*No. 15—April 15, 1937.*

#### CONCHAS DAM AND RESERVOIR PROJECT.

Noyes.

The Conchas Dam is being built across the South Canadian River in New Mexico. The reservoir formed by the dam will store water for irrigation and will also act as a flood control reservoir. This article gives a history of the project and describes the basin of the South Canadian River the upper portion of which is subject to floods causing great damage. The work was started in August 1935 and is scheduled for completion in 1939. The construction camp is described in detail. Hydrologic studies of the river basin undertaken to determine the necessary capacity of the reservoir are described. A balanced allocation of

storage was decided upon to satisfy demands of flood control and needs of irrigation. The dam will be a concrete gravity structure 235 ft. high, 1250 ft. long, with an overfall spillway 340 ft. long, located in the main body of the dam. The geological conditions of the dam site are described. The total capacity of the reservoir is 500,000 acre ft. The capacity up to spillway crest level is 300,000 acre ft. and this is allocated to irrigation. Provision has been made to increase irrigation storage by 100,000 acres ft. by the future installation of automatic gates on the spillway. The project will also require the construction of about 13,650 ft. of dams and dykes composed of earth embankments. A concrete overfall weir 3,000 ft. long will form an emergency spillway and will be a separate structure 2,000 ft. to the north of the main dam.

ROADSIDE EROSION CONTROL STUDIED BY SOIL CON-  
SERVATION SERVICE.

Davis.

In the states of Louisiana, Arkansas and Texas there are over 500,000 miles of roadside ditches in the design of which no consideration was given to the problem of erosion. The sides and bottom of these ditches are badly scoured by rushing rain water. The soil conservation service is planning to construct a number of highway control demonstrations. Methods to be demonstrated include proper design of waterways for desired velocities, growing vegetable cover on the slopes of ditches, use of intercepting terraces on non-erosive grades, and use of masonry drop inlets to divert outside water into the waterways.

HOLLOW CONCRETE RIGID FRAMES SUPPORT  
AUDITORIUM ROOF.

Wright.

Describes a hollow girder roof supported by hollow columns of reinforced concrete recently built for a school auditorium in California. The span is 77 ft. and the columns are 26 ft. high. Details of the hollow columns and girders are given and construction methods are described.

NOMOGRAPHIC RELATIONSHIP OF HYDRAULIC FRIC-  
TION FACTORS.

Overshiner.

In dealing with hydraulic problems involving flow of water through pipes or conditions, one of three formulæ is generally used. These are the Chezy formula, the Manning formula, and the Weisbach formula. Each of these formulæ involves a coefficient. It occasionally becomes necessary to know the value of one of these coefficients corresponding to that of another. The relation between

these coefficients can be expressed by two equations. A nomograph has been prepared which gives a ready solution of these equations for all cases likely to be met with in practice. An example illustrating the use of the nomograph is given.

#### RIVER RESOURCE MANAGEMENT.

Editor's comments on the report of the Water Resources Committee on the drainage basin survey accomplished in the U. S. A. When the administration asked for the survey, it expected to obtain a ready-made programme for a national construction campaign, but the survey has produced no such result. The survey is a listing of a number of projects affecting river use and abuse, and in addition, a partial sifting and co-ordination of these projects. The listing is incomplete. The report is only a preliminary index of future river development problems and undertakings. The survey points to two conclusions. Firstly, intensive study of each basin and each problem in that basin must follow the present survey. Secondly, a means of continuous correlation of State and Federal authorities must be established. A permanent bureau or board should be set up operating under a code of objectives and principles laid down by the Congress.

#### CURRENT NEWS.

A large installation of a central water cooling plant for air conditioning of a number of separate buildings is under construction in Washington. The 6,000 H. P. plant will have a water cooling capacity of 8,000 gallons per minute to a temperature of 40°F.

*No. 16—April 22, 1937.*

#### SQUEEZE TEST FOR INTEGRITY OF SOIL SAMPLES.

Burmister.

Samples of soil which are taken in the field and transferred to the laboratory for the study of undisturbed soil, are always subject to a certain amount of disturbance during handling and transit. A method of selecting the least disturbed sample in the laboratory has lately been developed and has been called the squeeze test. The device used for the test and the procedure are described in this article.

#### SERIOUS LEAK CHECKED IN COFFERDAM AT GRAND COULEE.

Serious leaks occurred through the base of the Cofferdam which keeps the Columbia River out of the area in which the east section of the Grand Coulee Dam is being built. One cell of the Cofferdam collapsed as a result of this leakage.

Steps were taken to check the inflow and protect the area within the Cofferdam. These are briefly described. Later, a plan for strengthening the Cofferdam, and stopping the leak was decided upon and has been put under construction. The plan consists of building an auxiliary ring of gravel filled sheet pile cells, seven in number, the intervening space between the old and new cells being filled with sand and gravel. Timber cribbed drainage wells will be placed behind the auxiliary cells so as to reduce the flow of water sufficiently to permit effective grouting of the leaks. An experimental model has been built and experiments are being carried out to determine the best material for grouting.

*No. 17—April 29, 1937.*

(City Engineering Number.)

#### NEW STREETS FOR OLD.

Factors which should govern modern road design are discussed in this article. Streets must be designed to move traffic as speedily as possible with the highest degree of safety to everyone. Street surfaces can no longer be made smooth but must purposely be roughened to increase friction between the tyre and the pavement. The recently developed de-aerated vertical fibre paving bricks, the practice of removing surplus bituminous filler from the surface of brick payments sand paper finish on concrete payments, and the open type of bituminous surface, are modern examples of non-skid road surface construction. Inter-section design, lighting and devices for the safety of the pedestrian, are discussed.

#### STREET MAINTENANCE.

Shafer.

Street maintenance methods as adopted in the State of Pennsylvania are described in this article. The satisfactory maintenance of dirt roads is one of the major problems. The method of surfacing them consists of covering them with a light layer of air cooled slag and treating with an asphalt dust layer afterwards. The resulting surface is smooth and hard, and more or less moisture proof.

*No. 18—May 6, 1937.*

#### HYDROMETER COMPUTATIONS IN SOIL STUDIES SIMPLIFIED.

Bauer.

The determination of the percentages of the various sizes of soil particles smaller than the No. 200 sieve made quite generally by the hydrometer method. One type of hydrometer developed by Casagrande measures the density of

the suspension at some depth below the surface. The formula relating the diameter of the particles to the specific gravity of soil, specific gravity, and viscosity of the liquid used in the suspension, and other factors, is a complicated one and involves lengthy computation. The writer of this article has prepared tables for facilitating the computations which are presented. An example, illustrating the use of the tables is given.

#### NEW CREST GATE FOR DAMS.

Bauknight.

Emsworth Dam on the Ohio river which is a navigation dam is under reconstruction. The present dam is a fixed dam founded on timber piles. The new dam which adjoins the old one on the upstream side is founded on H section steel bearing piles 30 ft. long. The old dam will serve as an apron and baffle below the new section. The new dam consists of a fixed section and a number of piers for vertical lift gates working between the piers. As the river channel is divided into two sections by an island, the dam is also in two sections. In one of the sections there are 8 vertical lift gates. In the other section there are 6 gates of which 5 are the ordinary vertical type lift gates and one is a special type of gate called the Sidney gate. (All the gates are 11 ft. deep by 100 ft. long.) This gate could be described as a combined radial and lift gate. It tilts to part opening by revolving and then lifts vertically to the height required to clear the opening. The gate is triangular in cross section, the upper and lower legs are trusses and the upstream face consists of a girder. The skin plate forms a segment of a circle. The advantages of this type of gate over the tainter and the vertical lift gates are compared and the comparative weights of the three types of gates are given.

#### LATERAL LOADING TESTS MADE ON STEEL BEARING PILES.

Vierheller.

Describes the procedure adopted for tests on large H section piles driven about 30 ft. into sand and gravel underneath Emsworth Dam to determine what lateral loads could be assumed in the design of the structure.

*No. 19 — May 13, 1937.*

#### LARGE STEEL PENSTOCK PLACED IN TUNNEL AT FORT PECK.

Pence.

Describes the erection of a steel pipe 24 ft. 8 in. in diameter inside tunnel No. 1 of the Fort Peck Dam. The tunnel is 32 ft. 2 in. excavated diameter, braced with structural steel ring beams and purlins, and lined with 21-inch thick concrete thoroughly grouted into the rock. Inside this

has been placed a tube 24 ft. 8 in. in diameter made of riveted steel plate of 1 inch thickness. Between the steel tube and the concrete lining is a space 23 inches wide which has been filled with concrete and grout. Fabrication of the steel tube, assembly, and placement are described, together with the filling of concrete behind the pipe.

#### MODERN BUILDING DESIGN FOR A SMALL TOWN NEWSPAPER.

A newspaper building incorporating air conditioning, indirect lighting, exterior walls partly built of glass blocks, acoustical insulation, and glazed tile wall interiors has recently been completed in Iowa city. The air condition unit has been designed for automatic heating and humidifying of air in winter, and cooling and dehumidifying in summer. The air throughout the building will be changed every 20 minutes.

#### MEASURING SOIL MOISTURE.

Ehrenburg.

The U. S. Bureau of Reclamation laboratories in Denver have developed a portable electric instrument to determine the moisture content of sand and soil. The instrument is known as a moisture meter and was tested for two purposes: (1) control of moisture content of soil in earth dam construction and (2) determination of moisture content of sand for use in concrete. The results of the tests are discussed and it is concluded that the moisture-meter offers a quick and accurate method of determining the moisture content of soil and sand provided the material is uniform in composition and grading.

#### MARSHALL FORD DAM DESIGNED FOR RAISING IN FUTURE.

The Marshall Ford Dam being built by the U. S. Bureau of Reclamation on the Colorado River is designed for two-stage construction. The first stage construction provides for a concrete gravity dam 190 ft. high and 2,325 ft. long with an overflow spillway 730 ft. in length. The left end of the dam will be flanked by a rolled earth embankment 1,100 ft. long and 30 ft. high with a low concrete cut-off wall inside it. The dam will ultimately be raised to a total maximum height of 265 ft. The dam will be raised by widening on the upstream side while the place of the sloping front or downstream side of the dam will be extended upwards.

#### CURRENT NEWS.

##### EARTHQUAKES AT BOULDER DAM.

Earthquakes at Boulder Dam have been frequent of late. Sounds like explosions accompany the quakes. Because of the frequency of shocks since lake Mead has begun to

fill and the inference that this new water load on the earth's crust may be causing the quakes, it has been suggested that the U. S. Coast and Geodetic Survey should instal a group of instruments for a regular study of these seismic disturbances.

*No. 20—May 20, 1937.*

#### COFFERDAMMING DIFFICULTIES IN A NARROW TIDEWAY.

Albertson.

A new bridge is being erected to replace an old one at the mouth of the Shark river on the New Jersey coast in U. S. A. The foundation work was complicated by tidal currents, and obstructions in the shape of the old piles of the demolished bridge. Special methods were adopted for putting in the pile foundations of the piers. The Cofferdamming operations, method of dealing with the old piles and driving of new piles are described.

#### LAMINATED TIMBER ARCHES SUPPORT MUNICIPAL AUDITORIUM ROOF.

A special type of timber arch was used for the roof of a municipal building at Jamestown, U. S. A. Ten arches of 120 ft. span were put up in the 200 ft. length of the building; each arch consists of two flanges, with a web in between. Each flange consists of 8 planks 1 inch by 12 inches while the web consists of two stacks of 4 inch by 3 inch timbers, the whole held together by  $\frac{5}{8}$  inch machine bolts 2 ft. long. Assembly and erection are described.

#### WELDED ROAD BRIDGE GIRDERS BUILT ON 70 FT. SPAN.

Bloch.

Welded plate girders 71 ft. 8 in. long—the longest in America—and 72 inches deep were used in a highway bridge in New York county. The design is described in brief.

#### FORT PECK SHAFT LINING.

Pence.

Under the right abutment of Fort Peck Dam, there are 4 tunnels 24 ft. 8 in. in diameter through which the Missouri river will be diverted. Near the axis of the dam each tunnel is intercepted by a 50 ft. diameter main shaft that will house the cylinder gates by which the flow past the dam will be regulated. These shafts were excavated 60 ft. in diameter and are lined by a 5 ft. shell of reinforced concrete in which is embedded a welded steel plate cylinder. This article describes the details of the lining and outlines the procedure of construction.

#### STEEL PIPE 11 $\frac{1}{2}$ FT. IN DIAMETER WELDED BY IMPROVED METHODS.

On colorado river aqueduct steel pipes 31/32 in. thick are being welded in place in the trench. The inner surface is being enamelled while the outer surface is being protected with 'shotcrete' or concrete forced under pressure. The details of the methods employed are described in this article.



No. 21—May 27, 1937.

# **FORT PECK DAM CLOSURE SLOPES DRAINED BY PERFORATED METAL PIPES.**

The Fort Peck hydraulic fill earth dam is being built in two sections one on each bank of the river. The slopes of the fills facing the river are called closure slopes. Seepage from the closure slopes developed some time ago and the slopes became unstable at the toe. Perforated pipe drainage systems were installed with very successful results.

## **FINDING GOOD SUBGRADE MATERIALS.**

The Arizona Highway Department is conducting tests to develop a test measure of the stability of subgrade materials. This article describes the apparatus used, and the method of testing.

## **PARTIAL FLOOD-CONTROL STORAGE VALUABLE IN EXTREME**

HIGH WATER.

Grimm.

Reservoirs for flood control usually have great value over a long period of years even though their capacity is not sufficient for full control of the larger floods. This point is illustrated in this article with the help of two diagrams which refer to a portion of the Willamette River flood plane that would be benefited by a system of reservoirs now under consideration.

## **VEHICLE TUNNEL TO BE BUILT UNDER MASS RIVER AT**

ROTTERDAM, HOLLAND.

Gives the principal details of a tunnel to be constructed. The tunnel will be of rectangular design with two traffic channels, one for vehicles and the other for bicycles and pedestrians. The portion of the tunnel under water will be prefabricated in 229½ ft. long sections on the shore and will be sunk and connected up in the water. The shell will be lined with 1.64 ft. of reinforced concrete.

## **JOURNAL OF THE AMERICAN WATER WORKS ASSOCIATION.**

VOL. 28.

No. 4—January 1937.

## **DESIGN OF EARTH FILL DAMS.**

Wyckoff.

This article sets forth in general terms, the principles governing the design of an earth fill dam, and the factors to be considered in order to evolve a safe design. The cross sectional dimensions of a dam are governed by the stability

and perviousness of the foundation material as well as the material in the fill. Detailed study and laboratory tests of foundation material at various depths are the first essentials. The plasticity under a saturated condition and the percolation rate should be determined for the foundation soil. The rate of percolation through the material of the fill should also be determined by laboratory tests. The upstream slope should be flat enough to prevent sloughing of the material in the reservoir when the reservoir is suddenly emptied and the slope of the line of percolation is reversed. The protection of the upstream face from wave action is also necessary. Cut-off walls are useful if they can be extended to some formation more impervious than the one on which the dam rests. If the dam rests on rock, grout holes are necessary in the vicinity of the upstream toe to seal fissures in the rock. Considerations affecting the design of outlet works are briefly discussed.

#### SOIL COMPACTION CONTROL FOR ROLLED EARTH DAM CONSTRUCTION.

Proctor.

Many engineers consider soils for earth dams on the basis of watertightness alone without regard to the extent to which the soil should be compacted to resist softening from saturation. The saturated plasticity of the compacted soil is however much more important than watertightness alone. As a result of tests conducted by the author, he found that specimens of a particular soil that were compacted at the highest and lowest moisture contents were the most pervious, while specimens of the same soil compacted at an intermediate moisture content were impervious in the desired degree. The procedure of determining experimentally the maximum moisture content and plasticity that should be permitted during compaction is described in this article.

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#### JOURNAL OF THE AMERICAN SOCIETY OF AGRONOMY.

VOL. 28.

No. 4—April 1936.

#### STUDIES ON THE USE OF THE TERRACING PLOW FOR SOIL CONSERVATION.

Harper.

The terracing plough is an implement to build terrace ridges which protect the soil from erosion by reducing the quantity of run-off of water. Studies were made to determine the limitations of this implement in a soil conservation programme and the results are presented.

## PHYSICS.

VOL. 7.

No. 3—March 1936.

**SOME APPLICATIONS OF PHYSICS TO AIR CONDITIONING.**

Pugh.

The term air conditioning is applied to the cleaning of air and to the control of its humidity and temperature. This article deals with temperature control. The "heat pump" system of heating a building is discussed. In this system, the same equipment can be used for both heating and cooling. The use of this system is however limited to milder climates or to locations where plenty of water is available. In the design of cooling systems, the nature of heat flow into a building needs detailed consideration. Average flow of heat through a wall, the maximum heat flow, and the time of arrival of this maximum heat flow require to be accurately determined. The author has indicated a graphical method of determining the above factors based on a mathematical solution of the problem by the author. A typical curve showing the variation with time of the temperature of the surface of roof panels exposed to the summer sun is also included. Experiments were conducted by the Research Bureau of the American Society of Heating and Ventilating Engineers to determine the relations between internal surface temperatures and temperatures of the external surfaces exposed to the sun, and also the time lag of maximum internal temperatures behind the maximum external temperatures. The results are presented in the form of curves.

**THE SEEPAGE FLUX UNDER DAMS OF EXTENDED BASE  
WIDTH AND UNDER COFFER DAMS RESTING ON  
PERMEABLE STRATA OF FINITE THICKNESS I.**

Muskat.

In this article, an exact theory is given of the seepage flux underneath dams of extended base width, with and without sheet piling, and under coffer dams with variable depths of excavation on the downstream side. Three cases are dealt with, viz. (1) dams of extended base width and no sheet piling, (2) dams of extended base with sheet piling and (3) coffer dams. In each case, an equation for the seepage flux per unit potential drop has been derived by a process of mathematical analysis based on the method of conjugate functions. Curves have been plotted based on the equations derived giving the seepage flux in terms of the ratio of dam width to thickness of permeable stratum, the depth and position of piling, and depth of penetration of coffer dam. Curves showing

pressure distribution at the base of dams with and without sheet piling are also given. Conclusions arrived at may be summed up as follows. The effectiveness of sheet piling in cutting down the seepage flux is a maximum when it is set at the heel or toe of the dam, and increases as the ratio of the thickness of the permeable stratum to the dam width increases. Although the flux decreases with increasing piling depth, a large portion of flux persists till the piling penetrates to the very bottom of the permeable stratum.

## PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

VOL. 63.

No. 3—*March 1937.*

This issue contains a symposium on National Aspects of Flood

Control consisting of the following papers:—

### FEDERAL RESPONSIBILITY FOR FLOOD CONTROL.

Davis.

The importance of the problem of flood control and the need for national control and action are brought home to the reader in this article. Conditions in the state of Pennsylvania are discussed as typical of those elsewhere in the U. S. A. and arguments for Federal responsibility in flood control are cited.

### PROBLEMS IN DEVELOPING A NATIONAL FLOOD-PROTECTION POLICY.

Wolman.

In this article the writer discusses some aspects of national flood protection policy such as engineering, financial and administrative aspects and suggests the lines of approach to the development of a national flood protection policy. He has attempted to show that the development of a national flood protection policy should not be separated from that of a national water resources policy in general. A few undertakings are briefly described as examples of multiple use of streams.

### THE ECONOMIC ASPECTS OF FLOOD CONTROL.

Jacobs.

"Flood control is a problem of applied economics in which the social security and protection of life and property must be evaluated in balancing the annual savings from flood control against the cost of construction and maintenance". The writer discusses social security as a factor in evaluating flood control. The Flood Control Act of 1936 lays

down that it is proper for the Federal Government to participate in flood control projects if the life or social security of the people is in danger. The economic problem of flood control involves the question of selecting the most suitable type of works for flood control. The question of reservoirs for flood control alone, and multi-use reservoirs is discussed. The benefits of flood control, direct and indirect, are set forth, and the question of distribution of costs of a flood control project is discussed.

#### FLOOD CONDITIONS IN NEW ENGLAND.

Uhl.

This article describes the topography of New England and the two most disastrous floods which occurred in 1927 and 1936. The two floods are compared and the flood damages are evaluated. The question of prevention of flood damages by flood warnings, is discussed and suggestions are made to improve the service of the U. S. Weather Bureau which is responsible for flood warnings. Flood control works are then dealt with and the effectiveness of storage reservoirs for flood control is discussed. The working of two detention reservoirs is examined and it is concluded that these reduced the peak flow of the river by about 16 p. c.

#### THE NEW YORK FLOODS OF 1935 AND 1936.

Harrington. Johnson.

This paper describes the major drainage basins of New York state and describes the causes contributing to the occurrence of the floods of July 1935, and March 1936. The floods have emphasized the importance and value of basic hydrologic data. There is an insistent popular demand for flood control in the State as a result of the two floods in 1935 and 1936. The limitations imposed by nature on flood control projects are mentioned.

#### FLOODS IN THE UPPER OHIO RIVER AND TRIBUTARIES.

Morse. Thomas.

"The object of this paper is to describe the outstanding characteristics of the unprecedented floods of March 1936 in the upper Ohio River and its tributaries, to point out the causes which combined to bring about the occurrence of this flood, and to outline the history of the present flood control programme for these rivers. Recommendations are made for improving the facilities and technique used in forecasting floods in this region."

#### AN IDEAL ORGANIZATION FOR THE RIVER AND FLOOD SERVICE OF THE UNITED STATES WEATHER BUREAU.

Hayes.

The demand for flood forecasts has grown rapidly as the result of frequent floods and the standard of accuracy of such

forecasts demanded is constantly increasing. This necessitates additional observations and better methods of prediction. The writer has advanced a plan for improving the river and flood service of the U. S. Weather Bureau which essentially consists of more rainfall observation stations, surveys of amount and condition of snow in the mountains, arrangements for a more reliable transmission of rainfall and riverflow records from substations to the district centres and forming a number of sections of the country for river administration.

#### FEDERAL PLANS FOR FLOOD CONTROL.

Covell.

The Mississippi River basin is the largest drainage basin in America. The first flood protection sponsored by the Federal Government was in this valley. The history of flood control on the Mississippi River is outlined, and the gradual extension of Federal interest in flood control to other localities is reviewed, leading to the Flood Control Act 1936 which represents national planning on a country-wide scale. The project for the Ohio River basin authorized by the Flood Control Act of June 22, 1936 is described in detail. The general features of the reservoir system which contemplates control of flood waters at or near their source are presented. An abstract of the Flood Control Act of 1936 is given in an appendix.

#### PROGRESS REPORT OF THE COMMITTEE ON FLOOD PROTECTION DATA.

The Committee on Flood Protection Data presented its progress report for 1936 at the annual meeting of the Institution in January 1937. The report describes the flood studies undertaken. The recommendations of the Committee with regard to the steps to be taken to alleviate flood damage and the compilation and publication of flood data are set forth.

*No. 4—April 1937.*

#### THE PASSAGE OF TURBID WATER THROUGH LAKE MEAD. Grover. Howard.

Turbid water carrying a considerable load of fine silt was discharged from Lake Mead above Boulder Dam at three different periods during 1935. The turbid discharges represent the conveyance through and the discharge from the lake of as much as 6,000,000 tons of silt. There is evidence to show that silt laden water flowed through the reservoir essentially unmixed with the clear water in the reservoir. The phenomenon is ascribed to the greater specific gravity of the incoming water relative to the generally clear water at the surface of the lake. The

loads of suspended matter carried by the Colorado River are computed for two gauging stations, one 265 miles above the dam and the other 10 miles below it. The loads in tons per day carried at the two stations are represented graphically. A study of the curves shows that the flow of turbid water followed an increase in suspended matter recorded at the gauging station 265 miles above the dam. The flow also depended on the size of silt articles carried in suspension into the lake. It was only when the silt load carried into the lake was very fine that turbid water flow was observed below the dam.

The authors suggest that a study of conditions pertaining to the flow of silt through a reservoir is of great importance, as one of the unsolved problems of detention reservoirs relates to the gradual loss of capacity due to silt deposit. If means could be found whereby a considerable quantity of silt could be discharged out of the reservoir, its effective life would be increased.

#### **PRACTICAL USE OF HORIZONTAL GEODETIC CONTROL.**

Sheldon.

"An argument for the increased use of the horizontal geodetic control system is offered in this paper. It contains suggestions to the engineer when he is beginning to use this control, a description of the origin and use of this system which has been followed successfully in the Panama Canal, and an analysis of the errors developed by using this system of control in the canal and other zones". The writer concludes that plane surveying is out of date, and the system described is a valuable aid in performing all kinds of field engineering work.

#### **PRESSURES BENEATH A SPREAD FOUNDATION.**

Krynine.

Part I of this paper describes a graphical method of determining pressures under foundations with uniform and non-uniform loads and is called the reduced area method. Part II deals with pressures under rigid foundations.

*No. 5—May 1937.*

#### **EARTHQUAKE RESISTANCE OF ELEVATED WATER-TANKS.**

Ruge.

The problem of building an elevated tank which is truly earthquake resistant is considered in detail in this paper. A new design is put forward as a practical solution. Experimental work with models to study the stresses developed in a water tank due to vibration are described. Reproductions of actual earthquake motions were applied to models in the experiments. The result show that dangerous stresses are not avoided by designing against a

statical horizontal force as is generally assumed to allow for earthquakes. Rules for the design of structures of the new type suggested are given.

#### **HYDRAULIC TESTS ON THE SPILLWAY OF THE MADDEN DAM.** Randolph,

Madden Dam on the Chagres River in the Isthmus of Panama is being built to create a reservoir for storing water to be used for lock operation and for flood control. The main dam is of mass concrete gravity type 974 ft. long at crest and 220 ft. high, consisting of an overflow spillway section across the river with abutment sections on either side. The spillway is divided into four 100 ft. openings, and structural steel drum gates are installed on the concrete crests in these openings. The flood water passing over the spillway has a drop of 173 ft. to the toe and the velocity will be 100 ft. per second. It was found necessary to devise means of dissipation of this energy to eliminate erosion of the foundation rock.

Tests were made on a model of the dam built to a scale of 1 : 72 with various types of aprons including dentated sill apron and hydraulic jump apron of the level and sloping type and the last named was found to be the most effective. Detailed analysis of the experimental results has been made. Tests were also made with the model of other features of spillway design such as spillway retaining walls, drum gate operation, location of sluice ways through the spillway section, shape of deflecting lips over sluiceway exits. Conclusions arrived at from the results of the tests are set forth.

In order to check the model predictions test apparatus was installed at the dam itself and tested. The results obtained are described and are found to be consistent with the predictions made from the model tests.

#### **READJUSTMENT OF TRIANGULATION DATUM.**

Describes some methods of readjustment of an old triangulation to fit a new datum by applying corrections to old datum values.

#### **DISCUSSIONS ON THE FOLLOWING PAPERS APPEAR IN ONE OR MORE ISSUES OF THE PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS GIVEN ABOVE :—**

**VARIED FLOW IN OPEN CHANNELS OF ADVERSE SLOPE.**

**ADMINISTRATIVE CONTROL OF UNDERGROUND WATER :  
PHYSICAL AND LEGAL ASPECTS.**

**BACK-WATER AND DROP-DOWN CURVES FOR UNIFORM CHANNELS.**



**DYNAMIC DISTORTIONS IN STRUCTURES SUBJECTED TO SUDDEN EARTH SHOCKS.**

**ANALYSIS OF VIERENDEEL TRUSSES.**

**SIMPLIFIED METHOD OF DETERMINING TRUE BEARINGS OF A LINE.**

**SELECTION OF MATERIALS FOR ROLLED-FILL EARTH DAMS.**

**STRUCTURAL APPLICATION OF STEEL AND LIGHT-WEIGHT ALLOYS :  
A SYMPOSIUM.**

**ECONOMIC DIAMETER OF STEEL PENSTOCKS.**

**RECLAMATION AS AN AID TO INDUSTRIAL AND AGRICULTURAL  
BALANCE.**

**SURFACE AND SUB-SURFACE INVESTIGATIONS, QUABBIN DAMS  
AND AQUEDUCT : A SYMPOSIUM.**

**INTERACTION BETWEEN RIB AND SUPERSTRUCTURE IN CONCRETE  
ARCH BRIDGES.**

**STRESSES AROUND CIRCULAR HOLES IN DAMS AND BUTTRESSES.**

**DEFLECTIONS BY GEOMETRY.**

**FLOW CHARACTERISTICS IN ELBOW DRAFT-TUBES.**

**RAINFALL INTENSITIES AND FREQUENCIES.**

**STABLE CHANNELS IN ERODIBLE MATERIALS.**

**CONSTRUCTION AND TESTING OF HYDRAULIC MODELS, MUSKINGUM  
WATER-SHED PROJECT.**

**GRAPHICAL DISTRIBUTION OF VERTICAL PRESSURE BENEATH  
FOUNDATIONS.**

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**THE RECLAMATION ERA.**

**VOL. 27.**

*No. 2—February 1937.*

**BOULDER DAM PLAYS ITS PART IN RECLAMATION.**

**Young.**

This article is a brief review of the objects of the Boulder Dam and the benefits which have resulted from its construction. The Colorado river in its lower reaches flows across the hottest and driest part of the U. S. A. Without regulation, the river was of little value to this lower basin area. The quick run-off and the absence of summer rains made any large irrigation development impossible. Moreover, the floods in the river were a menace to life and property in the area. There was a constant demand for a secure water supply and protection from flood menace which compelled the attention of the Federal Government and resulted in the construction of the Boulder Dam. The benefits which have accrued from the project are:—

1. Control of floods. The upper 72 ft. of the reservoir having a capacity of 9,500,000 acre feet are reserved for flood

control purposes and is not to be encroached upon for storage of water.

2. Provision of adequate water supply.
3. Silt control. The Colorado transports silt to the delta past a given point at the rate of 330 tons per minute. This silt will be trapped to a very large extent in the reservoir.
4. Improvement in navigation will be made by conditions of regulated discharge provided by the storage.
5. Generation of Power.

#### DIVERSION OF COLUMBIA RIVER—GRAND COULEE DAM.

Markhus.

This article describes the operations in connexion with the diversion of Columbia river for building the centre section and east end of the Grand Coulee Dam. The operations include construction of two cross river coffer-dams, removal of upstream and downstream wings of the west side coffer dam and providing a channel for the diverted river.

#### HYDRAULIC MODELS AID DESIGN OF RECLAMATION STRUCTURES.

Barnes.

The study of hydraulic models in connexion with design of spillways, gates, transitions and other structures affecting control of water has come into general use in the U. S. A. within the past 6 or 7 years. Of 21 laboratories listed in the October 1935 bulletin of the National Bureau of Standards only 5 or 6 were in existence before 1930. Three of the new laboratories are operated by the Bureau of Reclamation. Some of the problems studied such as determination of approach and crest shapes of spillways, efficiency tests of turbine models etc. are quantitative. Studies of stilling pools, transition sections, scour below sills, and the like are comparative. Complete similarity between model and prototype is mathematically and physically impracticable. The major technical problem in applying model studies to design work is one of properly interpreting and allowing for unavoidable dissimilarities. The principal materials for models used in the reclamation laboratories are wood, sheet metal, cement, plaster and pyralin. The last named material has come into use recently. It is clear sheet celluloid which can be fastened at the edges to wood with screws or welded with acetone. It has a visibility as good as glass and can be drilled through without cracking. It permits of a motion picture of the flow being taken. In the cases of such important works as the Imperial Dam and the Grand Coulee Dam the designs were largely influenced by hydraulic model studies.

*No. 3—March 1937.***WATER CONSERVATION AND CONTROL.****Page.**

This is an address delivered by Mr. John C. Page, Commissioner of Reclamation in San Antonio, Texas. The importance of the conservation and control of water is emphasized. The work of the water resources committee of the National Resources Committee is reviewed. The collection of reliable hydrological data is of great importance for water control projects. The peculiar problem of Western America was that of irrigating its arid lands. The Water Resources Committee included in its recommendation list of projects in which the Bureau of Reclamation is interested. All projects since completed by the Bureau or in progress are included in the list. Boulder Dam is one of such projects. It is an example of the new type of Western water project. The Bureau of Reclamation is at present engaged in its largest construction programme consisting of seventy two contracts.

**THE ART OF PRESSURE GROUTING.****Minear.**

This article describes the grouting work done at the Boulder Dam. The work consisted of grouting of contraction joints, and grouting of foundations. The methods, and the equipment employed are described (See pages 72 and 76 of Bulletin No. 5).

**FOUNDATION EXPLORATION WITH 36-INCH DRILLS.**

A recent contribution to exploration work is the large diameter core drill which drills smooth walled holes sufficiently large in diameter to permit the engineer or geologist to enter the hole and examine the exposed section of the rock in place. Drilling is done by a rotating cylinder. The core is broken loose at the bottom of the hole by small charges of explosives inserted at a few points in the bottom of the circular cut, or by wedges driven between the core and the side wall of the hole. The core is lifted by means of a cable sling around the core. If the core is too friable to be removed intact, sections of the core are broken and removed by a large auger. The Bureau of Reclamation has used 36 inch diameter core drills with advantage on some of its large projects. Drilling costs are given. The drilling operations at Friant and Kennett Dam sites, Central Valley Project, California, the Hamilton Dam, and the Marshal Ford Dam are briefly described.

*No. 4—April 1937.***DEDICATION OF MARSHALL FORD DAM, COLORADO  
RIVER PROJECT, TEXAS.**

Addressed delivered by the Secretary of the Interior, U. S. A. on the occasion of the celebration of the beginning of work on Marshall Ford Dam. The dam is being built mainly for control of the river and protection from floods. It will be a concrete gravity dam, 2,325 ft. long, 190 ft. high and will create a reservoir with a capacity of 600,000 acre ft. It will be built in 2 stages. The ultimate height of the dam will be 265 ft. and with this height it will store 3,000,000 acre ft. Some other structures being constructed by the Bureau of Reclamation are briefly referred to.

**PARKER DAM, HALF COMPLETED. SERVES USEFUL  
PURPOSE.**

The Parker Dam is in course of construction on the Colorado River. Excavation for foundations of the dam was in progress behind two temporary cofferdams by which the river was diverted to flow through two tunnels. At this stage a big flood occurred on the Colorado and the Cofferdam was raised and strengthened immediately. More than 50,000 acre ft. of water was impounded at the dam site. The effect of the flood was not felt below Parker Dam site.

**CENTRAL VALLEY PROJECT.**

The Central Valley Project is designed to provide better distribution of water in the two valleys of the Sacramento and San Joaquin Rivers in California. The primary purposes are to supply irrigation water in the San Joaquin Valley where agriculture is endangered by depletion of underground water supplies and to increase the low flow of the Sacramento river to prevent encroachment of salt water from San Francisco Bay upon the Sacramento San Joaquin Delta. There will be two storage on the two rivers.

*No. 5—May 1937.***SALT RIVER DELEGATION VISITS BARTLETT DAM Koppen.  
SITE.**

A group of 100 people including the Board of Governors visited the site of the Bartlett Dam to celebrate the placing of the first concrete. Bartlett Dam is being built to develop 242,000 acre of farm land in the Valley of the Sun, and will harness the floods on the uncontrolled Verde River and make the water available for irrigation. It will store

200,000 acre ft. and will be a multiple arch dam 270 ft. high, with 10 arches of 60 ft. span with two short gravity sections at each end, the total length being about 800 ft. The spillway will have a capacity of 175,000 cusecs, and the discharge will be controlled by three 50 ft. by 50 ft. fixed wheel gates.

#### POWER DEVELOPMENT ON FEDERAL RECLAMATION PROJECTS.

In this article, power generation as a part of the programme of the Bureau of Reclamation since its inception to the present day is discussed. In the earlier days of the Bureau's work, power generation was merely to provide power during construction for construction operations. Later on power generation was undertaken to provide energy for pumps used in irrigation and drainage. In the latest projects typified by Boulder Dam power generation is deliberately included as a major consideration and is expected that the sale of power will contribute largely to the repayment of the cost of construction. Brief histories of power developments on various projects with summaries of their performances, rates, revenues, and obligations are given.

#### POWER GENERATION AT BOULDER DAM.

The initial installation of generating equipment at the Boulder Dam power plant has been completed. Four generators, each of 82,500 kilovolt-ampere capacity, largest in the world, have been installed, and placed in operation on the line serving the city of Los Angeles.

#### GROWTH OF LAKE MEAD.

Lake Mead formed by Boulder Dam is now 98 miles long and covers 67,500 acres. The storage has reached 10,000,000 acre ft. which is approximately one third the full capacity of the reservoir.

#### TOWERS USED ON TOPOGRAPHIC SURVEY OF THE MARSHALL FORD RESERVOIR SITE, COLORADO RIVER PROJECT, TEXAS.

Plane table topography to a scale of 500 ft. to an inch with 10 ft. contour intervals was decided upon for the site of the Marshall Ford Reservoir. The work however was hampered in heavily timbered localities and a portable tower for the topographer to work upon was built and put in use. It is 22 ft. 6 inches high with a base 2 ft. 6 in. square and a 5 ft. square working platform.

## SOIL SCIENCE.

VOL. 42.

*No. 1—July 1936.*

RECLAMATION OF ALKALI SOILS BY ELECTRO-DIALYSIS.

Puri. Anand.

Alkali soils owe their characteristic features to the presence of exchangeable sodium. When an electric current is passed through the soil, the soil particles being negatively charged move towards the anode and the exchangeable bases towards the cathode. To investigate the possibilities of using this method on a field scale to reclaim alkali land by the separation of sodium, some laboratory experiments and field trials were carried out at the Punjab Irrigation Research Institute. These experiments and trials are described in this article and results are discussed. The investigations show that it is possible to remove sodium from alkali soils on a field scale by this method.

## WATER WORKS &amp; SEWERAGE.

VOL. 83.

*No. 5—May 1936.*WATER: A DISCUSSION OF FLOWS, FRICTION  
MEASUREMENT AND POWER.

This article furnishes information and data on the design of pipe lines, and measuring devices such as venturi meters and pipe orifices. A general discussion of the flow of water through pipes, open channels, orifices etc. is given, and the formulæ in use are stated. These include the Chezy formula, and the Hazen-Williams formula. A table of coefficients to be used in the Hazen-Williams formula is given. Tables of loss of head in pipes calculated from the same formula are given, and the measurement of flowing water is also dealt with. A table is given showing horsepower for 1 cubic ft. of water per second under heads of 1 to 2,000 ft. based on an efficiency of 80 per cent.

PRACTICAL HYDRAULICS.

Wilson.

This article deals with the sharp crested weir as a device for the measurement of flowing water in open channels or streams. One of the most commonly used formulæ for rectangular sharp crested weirs known as the Francis formula is given and a table of discharges based on this formula is included in the article.

PIPE LINE FRICTION COEFFICIENTS.

A summary of the findings of the Committee on Pipe Line Friction Coefficients.

## WATER WORKS ENGINEERING.

VOL. 89.

*No. 18—September 2, 1936.*

TRANSFORMING SURFACE WATER INTO UNDER-      Lane.  
GROUND STORAGE.

Water spreading is the artificial application of water upon the ground surface in such a manner as to allow the water to sink into and become part of the underground water. By spreading water over pervious areas ground water is augmented and water otherwise wasted is stored for future use. This article discusses economical and legal aspects of water spreading, lays down principles to be observed in the selection of spreading areas and describes the methods generally used in Southern California for spreading water. These methods are the ditch or furrow method, the basin method and the well or shaft method. Conditions under which the different methods are used are given. Spreading by wells and shafts is expensive. The basin method has been found to be the most suitable to meet all conditions.

## THE AGRICULTURAL JOURNAL OF BRITISH GUIANA.

VOL. VII.

*No. 2—June 1936.*

PADI CULTIVATION IN BRITISH GUIANA.      Burnett.

The present methods and conditions under which paddy cultivation is carried out in British Guiana are reviewed in this article.

FERTILISER INVESTIGATIONS WITH PADI.      Follett-Smith.

Describes results of manurial experiments with paddy conducted at the Botanic gardens, Georgetown.

## THE AUSTRALIAN SURVEYOR.

VOL. 5.

*No. 8—December 1, 1935.*

SURVEYING IN CONNECTION WITH MODERN DAM      Cohen.  
CONSTRUCTION.

Survey methods adopted in the construction of the Wellington Dam in Australia are described in this article. The dam is a concrete gravity dam 750 ft. long, consisting of 2 straight

wings joined by a curved section of 300 ft. radius. The height from foundation level is 64 ft. The upstream face is vertical and the downstream slope has a slope of 1 : 2 upto 35 ft. from the foundation level, from which point it is curved to the crest. Expansion joints were provided at every 50 ft. horizontal distance. The survey included a traverse of the top water level, determination of the most economical site for the dam, location of expansion joints, and layout. Some details of actual construction of the dam are also given.

#### BAROMETRIC LEVELLING.

Miller.

The use of the aneroid barometer for levelling purposes is dealt with in this article. The formula used for reducing the barometric heights from observations is explained. The shortcomings of the aneroid barometer for levelling are discussed and the field procedure is outlined.

#### JOURNAL OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, AUSTRALIA.

VOL. 10.

*No. 2—May 1937.*

No articles of interest to irrigation engineers.

#### JOURNAL OF THE INSTITUTION OF ENGINEERS, AUSTRALIA.

VOL. 9.

*No. 2—February 1937.*

#### MODEL ANALYSIS OF AN ARCH SPAN OF 344 FEET.

Bull.

This paper describes a model investigation of the stresses in the main 344 ft. arch span of the bridge over Long Bay. The analysis was made by means of a special deformer apparatus which is specially suitable for this type of work and gives accurate results. The apparatus is described. The construction of the model and methods of analysis are described and the common errors are discussed. An analysis of temperature stresses is also included.

*No. 3—March 1937.*

*No. 4—April 1937.*

There is nothing of interest to irrigation engineers in these issues.



No. 5—May 1937.

**ELECTRIC WELDING OF STEEL BRIDGES.**Karmalsky.  
Linton.

This paper describes some bridge works carried out with electric arc welding and gives a comparison of weights of steel work in welded, riveted, and shop welded, field riveted structures. Design, fabrication and erection in the field are discussed.

**DISCUSSIONS & COMMUNICATIONS.****THE DESIGN AND CONSTRUCTION OF COMPOSITE  
SLAB AND GIRDER BRIDGES.**

Knight.

Mr. Bridgland contributes a written discussion on the above paper which was published in January 1934 issue of the Journal. He gives an analysis of shrinkage stresses in a composite slab and girder, and considers the factor of creep in the concrete affecting stresses. He suggests the use of an effective modulus of elasticity according to the amount of creep. He considers that in the design of composite sections, shrinkage and creep are both factors which are to be taken account of.

**PUBLICATIONS OF VARIOUS GOVTS., INSTITUTIONS  
SOCIETIES, ETC.****INDIA.****Central Government.****AGRICULTURAL STATISTICS OF INDIA, 1933-34,**

VOLS.

**I. II.**

This is an annual report in two volumes published by the Department of Commercial Intelligence and Statistics, Government of India. Vol. I gives figures of area, classification of area, area under irrigation, area under crops, live-stock, land revenue assessment and harvest prices in British India, while Vol. II gives similar data for Indian States.

**AGRICULTURAL STATISTICS OF INDIA, 1934-35,****VOL. I.**

See notes above.

**CONTROL OF MALARIA IN DELHI : REPORT OF THE  
ANTI-MALARIA COMMITTEE, 1936.**

The proposal to cut off the Western Jumna Canal some distance above Delhi and fill in its bed was considered. The importance of closing the canal in this way was stressed by the Committee but they were of opinion that considerable administrative difficulties are likely to arise if these schemes are carried into effect.

The report contains separate notes by the Director, Malaria Survey, Consulting Engineer, Malaria Survey, the Superintending Engineer, Western Jumna Canal Circle, and the special sub-committee of engineers.

**SCIENTIFIC REPORTS OF THE IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, FOR YEAR ENDING JUNE 30, 1936.**

The research work includes large scale experiments on the economical methods of green manuring with sann hemp, yield trials of some types of wheat, sugarcane breeding work in Coimbatore, insect pest investigations, and sugarcane mosaic investigations.

Programme of future work is given and includes work on the breeding of wheat, barley, oats and maize, study of soils for their physical, chemical, and micro-biological properties, survey of plant diseases and work on sugarcane breeding at Coimbatore and Karnal. Reports of the Imperial Agriculturist, Imperial Economic Botanist, the sugarcane expert, the Imperial Agricultural Chemist and the Imperial Mycologist are embodied in this publication. The report of the Imperial Agriculturist gives details of experiments with river silt for manuring sugarcane at Pusa. Chemical composition of the silt is given. Though the results of similar experiments during the two previous years indicated a better prospect for silt, the same was not maintained in the present year.

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**RULES OF THE LIBRARY OF THE IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI.**

I.—NOTE ON THE RESULTS OF AFFORESTATION OF  
JAMNA, CHAMBAL AND OTHER RAVINES.

Sah.

II.—NOTE ON SOIL EROSION IN THE PUNJAB.

Gorrie.

I—There are extensive waste and ravine lands along the Jumna and Chambal rivers in the United Provinces. A scheme of afforestation of the ravines along these rivers was started in 1912 and continued for 15 years. During this period 16,650 acres of ravine land were planted with timber and fuel species. The results of the operation of the scheme are discussed and it is concluded that ravine management and prevention of erosion are questions of control of grazing and improvement and preservation of grasses. It is the grasses that matter and not trees as a preventive of surface run off and erosion. It is usually mere waste of money to introduce timber or fuel species with the hope of making

an afforestation scheme pay. Indigenous fuel species can be improved and their natural regeneration can be encouraged at very little cost. Small earth dams at the heads of ravines are useful in preventing soil erosion.

II.—The second note deals with erosion conditions in the Punjab. (See bulletin No. 5, page 154).

**RULES ISSUED BY SURVEY OF INDIA DEPARTMENT REGARDING THE EXECUTION OF LITHOGRAPHIC OR PHOTOGRAPHIC WORK.**

**REPORT OF THE SCIENTIFIC ADVISORY BOARD FOR THE YEAR 1ST JANUARY TO 31ST DECEMBER 1936**  
(Issued by the Indian Research Fund Association).

The report deals with medical and nutrition researches carried out during the year. The Malaria Advisory Committee passed a resolution as follows :—

‘(Since a large amount of Malaria is produced in India by the execution of engineering projects, this Committee recommends that all engineers should be required to undergo a short course of training in the elements of tropical sanitation before taking up appointments in Government service’.

***Institution of Engineers (India).***

**JOURNAL OF THE INSTITUTION OF ENGINEERS (INDIA) INCLUDING THE TRANSACTIONS OF LOCAL CENTRES, VOL. XV, JULY 1935.**

**OPEN-END TYPE TUBE WELLS.**

Trivedi.

It is well known that yield of water from ordinary wells is very limited. If the well rests on ‘mota’ or a thick bed of clay and if this bed is pierced through and the water bearing stratum below is tapped, considerably larger quantities of water can be obtained. What actually happens is that when the clay bed is pierced, and water is pumped out, a good deal of sand rushes with the water into the well. This sand has to be removed and more sand drawn into the well till a sufficiently large cavity with clear water is formed below the clay bed.

The conditions governing this process and the limitations of this type of well were not known. With a view to ascertain these, two experimental wells were sunk, one at Unao and the other at Hathras in the United Provinces. The experimental wells were successful and were the foundations of the water-works in these places. In this article the author gives a brief description of the experimental wells together with the nature of the strata and the observations made and the conclusions arrived at.

TEMPERATURE STRESSES IN REINFORCED BRICK-  
WORK AND THE FAILURE OF REINFORCED BRICK-  
WORK ROOFS.

Raja Ram.  
Anand Saroop

Describes experiments carried out in the Physics Laboratory of the Thomason Civil Engineering College, Roorkee in 1932 with a view to determine the coefficient of expansion of steel, 1:3 cement and sand mortar, and specially selected 1st class brick. Hitherto it was the practice to ignore temperature in the design of reinforced brickwork, as the stresses in ordinary work are generally insignificant. As cracks have appeared several years after their construction in the reinforced brick roof slabs of buildings in Patna, Benares University and New Delhi, it was decided to investigate the causes. One of the obvious causes of failure of reinforced brickwork may lie in the difference between the coefficients of expansion of steel, brick, and cement mortar. The experiments described were undertaken to determine the coefficients for the materials named above. From the results of the experiments it is concluded in most cases the failure of reinforced brickwork can be traced to temperature stresses and difference in coefficients of expansion of the materials used.

THE ECONOMIC DIMENSIONS OF REINFORCED CON-  
CRETE RESERVOIRS.

Williams.

In this paper a method is described of arriving at the most economical dimensions of two types of open reinforced concrete reservoirs type A, those in which the thrust produced by the water pressure is resisted entirely by the tension in the horizontal reinforcements of the wall, and type B, reservoirs with walls built as retaining walls. Only uncovered types of reservoirs are dealt with.

THE POSSIBILITY OF FLOOD REGULATION AND CON-  
SERVATION IN THE HIMALAYAS FOR IRRIGATION OR  
POWER.

Meares.

This paper puts forward a proposal of building storage reservoirs in the Himalayan rivers by means of hydraulic fill or blasted earthen dams of great length and height, with by-pass tunnels of sufficient capacity to prevent any possibility of a dam being topped and destroyed by flood. The desirability of storage in the Himalayas has long been recognized but it was not considered an economic proposition. Recently the Severn Barrage Committee have made a proposal of closing the tidal shoots (deep and rapidly flowing channels) by dam consisting of two banks 500 to 1000 ft.

apart across the shoots with a filling of sand in the intervening space. This type of construction is suggested for the Himalayas along with bye-pass tunnels for diversion of the streams during floods. A procedure of construction is suggested. Such a dam according to the author would be unaffected by earthquakes.

PRACTICAL NOTES IN CONNECTION WITH THE CONSTRUCTION OF A REINFORCED CONCRETE SUBMERGIBLE BRIDGE OVER THE RIVER NERBUDDA NEAR JUBBULPORE.

Walton.  
Gupta.

The main features of design and construction of a reinforced concrete bridge which would be submerged during floods is described in this article. The reasons for selecting this type of bridge are :

- (1) The difference between the highest and lowest flood level is nearly 78 ft. During the flood season the river is a quarter of a mile wide and the maximum velocity is 15 ft. per second. In the dry season the river shrinks to a small channel 100 ft. wide and 2 or 3 ft. deep.
- (2) During high floods big trees complete with roots and branches are carried down the river.

The adoption of the submergible type was a distinct economic advantage. The piers are of stone masonry with open foundations. The superstructure consists of reinforced concrete arches with spans from 50 ft. to 105 ft. Three piers were erected on precast concrete pile foundations. The construction operations are briefly described.

MEMORANDUM, CONSTITUTION AND BY-LAWS OF THE  
MECHANICAL ENGINEERS' ASSOCIATION (INDIA).

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## BIHAR AND ORISSA.

*Public Works Department.*

MANUAL FOR THE USE OF THE IRRIGATION BRANCH  
OF THE PUBLIC WORKS DEPARTMENT OF THE  
BIHAR & ORISSA GOVERNMENT.

Contains rules regarding maintenance of embankments, procedure of dealing with irrigation and drainage schemes, rules and regulation regarding navigation rules for irrigation powers of Superintending and Executive Engineers, rules of land acquisition and procedure of leave, appointment, dismissal and punishment of officials.

## CENTRAL PROVINCES.

*Public Works Department.*EXTRACT FROM THE COMPLETION REPORT OF  
BORINA TANK PROJECT IN THE JUBBULPORE  
DISTRICT.

The stage I estimate amounted to Rs. 4,00,000 for works only and Rs. 4,98,000 including charges, and provided for a dam of the arched buttress type of a maximum height of 97.5 feet with a storage capacity of 157 m. cft. to command an area of 12,000 acres. After the construction began it was found that the foundation rock, which appeared to be sound at the time of survey, was much shattered and fissured. Thus it became doubtful if the reservoir could be made watertight. After careful examination it was decided to reduce the height of the dam by 25 feet, maintaining the same section as originally designed, and to construct a subsidiary earthen dam three-fourths of a mile downstream of the main dam and having a capacity of 18 m. cft. The idea in constructing the subsidiary weir was that it would hold the water leaking from the upper tank but the leakage from this dam is nearly as great as from the upper one. Gives also the description of sluices, waste weirs, etc., of the dams. A longitudinal section of the Borina dam is also attached.

## PUNJAB.

*Irrigation Department.**Punjab Irrigation Branch Technical Notes.*

NOTE, DATED 10TH SEPTEMBER 1922, ON THE  
GIBB TAIL OUTLET. (Class B, No. 1.).

Lindley.

This type of outlet is the first devised to distribute supply at the tails of channels independently of the differing and varying working heads of water courses. This type was also adopted in remodelling schemes of the Lower Chenab Canal. The note gives the results of tests undertaken to calibrate it accurately.

REPRINT OF NOTES ON (1) MATERIALS AND RATES,  
AND (2) EARTHWORK RATES, FOR THE UPPER  
JHELM CANAL, 1925. (Class B, No. 2.).

Farrant.

Notes on the manufacture of bricks, surkhi, ballast, lime, kankar lime, with analysis of rates. Specifications of finished materials and schedules of rates are also given.

NOTE, DATED 28TH JUNE 1922, ON THE USE OF  
PLAIN PIPES AS SEMI-MODULES. (Class B,  
No. 3.)

Lindley.

In this note the author has shown that discharge of a plain pipe is semi-modular as long as delivery level is slightly below the soffit at the delivery end. The calculations of head or depression necessary to give a designed discharge are explained. The author has used this method of calculation in using pipes extensively as semi-modules in the Jhang Branch of the Lower Chenab Canal.

REPORT, DATED 1ST MAY 1922, ON EXPERIMENTS  
CARRIED OUT ON THE WALTON RISING SILL  
GATE. (Class B. No. 4.).

Burkitt.  
Robertson.  
Gunn.

This is a report on experiments carried out with the Walton Rising Sill Gate in the Punjab by the authors. The method of conducting the experiments with various forms of this gate are described, and results are plotted graphically.

NOTES ON THE RESULT OF TEST CARRIED OUT ON  
SANDS FROM THE SUTLEJ RIVER AND PUNJAB  
PORTLAND CEMENT. (Class B. No. 7.) 1923.

Robertson.

It was decided by a sub-committee consisting of some Punjab Engineers and two representatives of the Punjab Portland Cement Company to undertake a series of tests with Sutlej sand and Punjab Portland Cement. The tests are detailed below :—

1. Tests of fineness, percentage of void and suitable grading of sand.
2. Testing ballast for voids.
3. Dry materials required per hundred cubic feet of completed concrete with mixtures in the proportion of 1 cement and 3 sand to 1 cement and 8 sand
4. Breaking tests, compression and tension.

The results of the tests are presented in this report.

SOLUTION OF QUADRATIC AND CUBIC EQUATIONS  
BY THE SLIDE-RULE. (Class B, No. 8.) 1924.

Lindley.

CONTRACTED VEINS. (Class B, No. 9) 1926.

Routh.

In this note are discussed the practical applications of the contracted vein principles in canal work. Examples of the

use of this principle are to be found in venturi flume outlets. Other uses advocated are :—

- (1) Portable contracted vein with curved approach and exit to measure discharge of water-courses.
- (2) Permanent masonry contracted veins to measure discharges of minors and moderate sized distributaries.
- (3) Contracted flume heads for distributaries.
- (4) Flumed bridges and syphons.

The special advantages obtained with a flume design in each of the above cases are discussed.

NOTE ON PROBABLE FULL SUPPLY FACTOR FOR  
RICE IN SINDH. (Class B, No. 10), 1925.

Chopra.

Dr. Summers, at one time Chief Engineer in Sind, criticized adversely the duties and full supply factors adopted for the Sukkur Barrage Canals. The views of Dr. Summers with regard to the length of the rice season in Sind, total depth of water in the field required for rice, and the duty, are criticized in this note and the author, has quoted his own experiments on the Upper Chenab Canal and elsewhere. He has given information about the amount of water needed for rice in different parts of the world. Conditions in Sind are analogous to those in the Lower Bari Doab Canal and it may be well expected that soon after the Barrage Canals are in operation, reasonable rice duties will prevail in Sind.

NOTE, DATED 15TH SEPTEMBER 1925, ON DAMAGE  
TO CHHATTA SYPHON AND THE METHOD ADOPT-  
ED TO REPAIR IT. (Class B, No. 13).

Uppal.

This Syphon is built on the Lower Chenab Canal. During a canal closure, water got into the canal bed from the syphon below, through which a flood was passing. Two lines of cracks were discovered extending through the arches of the syphon and the concrete bed of the canal. The method of repairing the damage is described.

REPORT ON A TOUR IN CANADA AND THE UNITED  
STATES OF AMERICA. (Class D, No. 1.) 1922.

Robertson.

The tour was arranged in order to obtain ideas which might assist in the construction of works which were being undertaken in the Punjab at the time. The works inspected include earthwork, concrete, masonry works, caissons, etc. A list of the works inspected is given. Special features are described and many illustrations are attached.



NOTE ON SHANNON POWER SCHEME. (Class D,  
No. 2.), 1928.

Robertson.

The Shannon Power Scheme is a very large hydro-electric project in the Irish Free State. The Shannon is the largest river in Ireland. The scheme comprises a weir across the river at which the head race of the power channel takes off on the right bank. There is a fall of 100 feet from the head race to the tail race. Design of the power schemes and construction operations are briefly described.

HISTORY OF THE JABA LEVEL CROSSING, UPPER  
JHELUM CANAL. (Class E, No. 3), 1927.

The Jaba Nadi crosses the alignment of the Upper Jhelum Canal, the natural bed of the torrent being one mile in width. Floods coming down the Nadi are passed across the Canal through the Jaba level crossing of which the Jaba weir forms the escape portion. The work was completed in 1912 but repeated damages occurred owing to high floods and repairs had to be undertaken in 1912, 1916, 1919, and 1921. Extensive repairs were undertaken in May 1926. Several Plates showing the various repairs undertaken are appended.

HISTORY OF THE CAPACITY OF THE UPPER  
CHENAB CANAL. (Class E, No. 6.), 1930.

The area proposed to be irrigated and the discharge of the canal have been revised since the original project. This publication gives details of the orders sanctioning the revision, and the revised areas and discharges.

HISTORY OF 1929 HIGH FLOODS IN INDUS,  
JHELUM AND CHENAB RIVERS. (Class E, No.  
7.), 1931.

Hydrographs of the various gauge sites on the three rivers are given and discharge curves where discharge figures were available. The flood of 1929 was abnormally high.

SERIES OF LECTURES ON IRRIGATION DELIVERED  
IN APRIL 1931 TO THE RURAL ECONOMY CLASS  
AT THE AGRICULTURAL COLLEGE, LYALLPUR.  
(Class B, No. 8) 1932.

Chopra.

These lectures describe the development and progress of irrigation in the Punjab and discuss the effects of irrigation on the life and conditions in the Province. Management of canals, points of contact with cultivator, and field distribution are also dealt with.

**HISTORY OF THE CAPACITY OF THE LOWER BARI  
DOAB CANAL. (Class E, No. 11. 1934.**

Gives a history of the revision of the discharges and proposed areas on the canal, and the revised figures for discharge, etc.

**HISTORY OF BALLOKI, HEADWORKS, LOWER  
BARI DOAB CANAL, FOR 1935-36.**

Works constructed, damaged and repaired are described. As a result of observation of the high residual pressures under the downstream floor, a model of the weir was tested in the Irrigation Research Institute at Lahore. It was concluded that the whole of the foundations below Bay No. 30 were degenerating. The question of strengthening the downstream floor was considered, but it was decided to construct, in Bays 1 to 25, a subsidiary weir immediately above the last line of wells. A suitable section was determined in the laboratory at Lahore.

*Punjab Canal Gazetteers.*

**LOWER JHELM CANAL, 1920. (Vol. I.).**

Gives history of the project, description of the area commanded. descriptions of the canal and works, maintenance and repairs of canal works, control and distribution of water. and details of capital cost, etc.

**TRIPLE CANALS (Upper Jhelum, Upper Chenab  
and Lower Bari Doab Canals). (Vol. II.).**

Gives history of the project, description of commanded area. details of water regulation and distributaries, etc.

*Publications of the Irrigation Research Institute.*

**THE GENERAL THEORY OF THE GRADIENT OF  
PRESSURE UNDER A STRUCTURE ON PERMEABLE  
FOUNDATIONS, WITH APPLICATIONS TO THE  
EVALUATION OF THE GRADIENT AT EXIT FOR  
SOME STANDARD CASES. (Research Publica-  
tion, Vol. II, No. 16, October 1935).**

Malhotra.  
McKenzie-Taylor.

The theory of the gradient of pressure is developed from first principles and its bearing on the velocity of flow at the angles of the structures indicated. The expressions for gradient at any point in the medium of flow are obtained and the values of exit gradient for the toe determined for a number of standard forms.

**THE SOILS OF THE RICE AREAS OF THE GUJRAN-  
WALA AND SHEIKHUPURA DIVISIONS OF THE  
UPPER CHENAB CANAL. (Research Publica-  
tion, Vol. III, No. 2, 1937.)**

**Mehta.**

A soil survey of the areas was undertaken with a view to determine the soil characteristics of the areas which have been continually under rice and to obtain information on the soil deterioration that has taken place. In all 238 samples were obtained and the results of the examination are given. Conclusions arrived at are set forth.

**A STUDY OF THE SOIL PROFILES OF THE PUNJAB  
PLAINS WITH REFERENCE TO THEIR NATURAL  
FLORA. (Research Publication, Vol. III,  
No. 3, August 1936.)**

**Hoon.  
Mehta.**

In the course of the soil survey of the Haveli Project, it was noticed that areas occurred in which certain types of natural flora appeared to be dominant. It was decided to examine the soils on which these dominant types of vegetation occur in more detail. The experimental work done is described and results are discussed.

*Agricultural Department.*

**REPORT ON THE OPERATIONS OF THE DEPART-  
MENT OF AGRICULTURE, PUNJAB, FOR THE  
YEAR ENDING 30TH JUNE 1936**

Agricultural research included irrigation experiments on cotton which showed that heavier irrigation increases the yield, and first irrigation should be given 3 to 4 weeks after sowing, no irrigation being necessary after the 15th October. Rice investigations include stages of transplanting, and effect of late planting. Mycological researches include investigations on sugarcane, wheat and fruit diseases. Experiments on reclamation of kallar soils by applying calcium are in progress. The activities of the Agricultural Engineering section were confined largely to well boring operations some of which are described. Programme of research work for the ensuing year is given.

**PUNJAB AGRICULTURAL DEPARTMENT SEASONAL  
NOTES, VOL. XV, No. 1, APRIL 1937.**

Contains short notes on agricultural matters which are useful to the cultivator. The following may be mentioned :—

1. Suggestion for maintaining and increasing the marketable value of Punjab wheat.
2. Trials with autumn planted sugarcane at the Agricultural Station, Gurdaspur.

3. Optimum time for sowing irrigated cotton in the Punjab.
4. Uses of Soyabean.
5. Where forestry helps the zamindars.

List of leaflets issued by the Punjab Agricultural Department is given. Seed agencies in the Punjab are mentioned. Improved agricultural machines are described.

## BOMBAY.

### *Public Works Department.*

GOVERNMENT OF BOMBAY, P. W. D., RESOLUTION No. 4042/27, DATED 2ND SEPTEMBER 1931.

Orders regarding the classification of crops on the major irrigation works in the Deccan Irrigation Circle, and the Irrigation Development and Research Circle. In the old classification the crops were divided into two classes, heavy and light. In the new classification, the crops have been divided into three classes, heavy, medium and light.

GOVERNMENT OF BOMBAY, P. W. D., RESOLUTION No. 5602/27, DATED 23RD SEPTEMBER 1933.

Orders regarding the water rates for irrigational and non-irrigational purposes on all the major and minor irrigation works in the Deccan Irrigation Circle.

GOVERNMENT OF BOMBAY, P. W. D., RESOLUTION No. 5602/27, DATED 3RD JANUARY 1935.

Orders regarding certain concessions in the water rates for irrigational purposes on the Nira Right Bank Canal.

GOVERNMENT OF BOMBAY, P. W. D., RESOLUTION No. 5602/27, DATED 3RD DECEMBER 1935.

Orders regarding the water rates for irrigational and non-irrigational purposes on all major and minor irrigation works in the Deccan Irrigation Circle.

GOVERNMENT OF BOMBAY, P. W. D., RESOLUTION No. 346/36, DATED 19TH MAY 1936.

Orders regarding the classification of crops of Soyabean and African Bajri.

GOVERNMENT OF BOMBAY, P. W. D., RESOLUTION No. 5602/27, DATED 29TH AUGUST 1936.

Orders regarding withdrawal of the concession of half rates in the case of long term fruit trees on the Nira Right Bank Canal.

**ANNUAL NOTE ON HYDRODYNAMIC, SOIL AND  
EFFLUENT RESEARCH CARRIED OUT AT THE  
EXPERIMENT STATION AT LAKE FIFE NEAR  
POONA, DURING 1935-36.**

Summary of the Report has already been given on page 4 of  
Bulletin No. 3.

*Agricultural Department.*

**ANNUAL REPORT OF THE DEPARTMENT OF AGRI-  
CULTURE IN THE BOMBAY PRESIDENCY,  
1935-36.**

Agricultural research work included research on soil erosion at Poona, experiments on manuring rice with sulphate of ammonia, breeding and manurial experiments with cotton and wheat, maintenance of soil fertility with farmyard manure, compost and bone manure, and plant diseases and pest investigations. Nitrogen fixation in rice fields is also being investigated.

**SIND.**

*Public Works Department.*

**MANUAL OF IRRIGATION FOR CANAL ASSISTANTS  
AND ABDARS IN SIND.**

**HINTS TO ENGINEERS IN CHARGE OF IRRIGATION  
IN SIND, 1931.**

Instructions for guidance of officers in matters dealing with bunds, maintenance of canals, regulators and bridges, bungalows and gardens, etc.

**GENERAL INSTRUCTIONS FOR THE OPENING OF  
NEW CANALS IN SIND, 1931.**

Contains instructions for guidance of officers when the new Lloyd Barrage canals were opened.

**INDUS RIVER COMMISSION RECORDS, 16TH  
OCTOBER 1933 TO 15TH OCTOBER 1934,  
VOLUME I.**

Contains Reports and Statements grouped in Parts I to III containing Gauge Readings, Discharges, Velocities and Silt Charges of the River Indus, Daily Withdrawals of Sind Canals, Rainfall Statements, various other Miscellaneous Observations, a descriptive note and important correspondence.

**INDUS RIVER COMMISSION RECORDS, 1933-34,  
VOLUME II, PART II.**

Contains drawings in connection with Statements in Volume I.

**INDUS RIVER COMMISSION RECORDS, 16TH  
OCTOBER 1934, TO 15TH OCTOBER 1935,  
VOLUME I.**

Contains Reports and Statements grouped in Parts I to III containing Gauge Readings, Discharges, Velocities and Silt Charges of the River Indus, Daily Withdrawals of Sind Canals, Rainfall Statements, various other Miscellaneous Observations, a descriptive note and important correspondence.

**INDUS RIVER COMMISSION RECORDS, 1934-35,  
VOLUME II, PART II.**

Contains drawings in connection with Statements in Volume I.

**STATEMENT OF FINAL AREA OF KHARIF CULTI-  
VATION FOR THE YEAR 1936 IN SIND.**

The note accompanying the statement says that the cultivation has been very good being 105·3 per cent. of that forecasted. The total area under rice was 5·45 lakhs acres and under cotton 9·25 lakhs acres. The total area of kharif cultivation was 18·40 lakhs acres.

**WEEKLY STATEMENTS SHOWING KHARIF CULTIVA-  
TION AREAS UP TO 26TH JUNE 1937 IN SIND AS  
COMPARED WITH THOSE OBTAINED UP TO THE  
CORRESPONDING DATE LAST YEAR.**

*Agricultural Department.*

**THE IRRIGATION OF DRY CROPS IN THE BARRAGE  
AREAS INCLUDING A SUGGESTED TIME-TABLE  
OF AGRICULTURAL OPERATIONS AND DISTRI-  
BUTION OF IRRIGATION WATER. Sind Agri-  
cultural Department, Leaflet No. 35 (1st  
edition, March 1934).**

Discusses irrigation requirements of kharif and rabi crops in Sind, rotation of crops, importance of including green manure crops in a rotation and the advantages of timely sowing of crops. A tentative programme of agricultural operations is given.

**IRRIGATION AND CULTIVATION OF THE RICE CROP  
IN THE BARRAGE AREAS OF SIND.** Sind Agri-  
cultural Department Leaflet No. 43 (1st  
edition, November 1934).

Contains important facts and considerations in connection with the irrigation of rice crop under Barrage water supply. Irrigation requirements of the rice crop are explained and a programme of irrigation operations for rice is given.

**A PRACTICAL METHOD OF UTILISING IRRIGATION  
WATER DURING OCTOBER FOR GROWING WHEAT  
CROP IN BARRAGE AREAS.** Sind Agricultural  
Department Leaflet No. 47 (1st edition,  
July 1935).

This leaflet describes in detail the methods, by the adoption of which, irrigation water in October can be fully utilized for growing wheat.

**A NOTE ON THE IRRIGATION OF FIELD CROPS IN  
THE BARRAGE AND NON-BARRAGE AREAS OF  
SIND.** Sind Agricultural Department Leaflet  
No. 50 (1st edition, March 1936).

The term 'cusec', 'duty' and 'delta' or 'depth of water' are defined and the duty in Barrage Canals is compared with that of short period inundation canals. The duty in the Barrage areas is higher than in non-Barrage areas. Practical methods of making full use of the irrigation over the whole period of its supply are suggested.

## MADRAS.

*Public Works Department.*

**IRRIGATION CIRCULAR MEMORANDUM No. 3075/  
36-C.E.P., DATED 21ST SEPTEMBER 1936.  
REGARDING THIPPAYAPALEM RESERVOIR BUND-  
BREACH.**

The reservoir was formed by an earthen bund flanked by surplus weirs on either side. The bund was 312 ft. long and 55 ft. high with a masonry core wall in the centre. Within two months of its completion there was heavy rain in the catchment and the bund was breached at two places on the two flanks where it joined on to the masonry of the weirs. Examination showed that the bund was consolidated hard, but the material forming the bund was of an alkaline nature. Further experiments with experimental

tanks made of this material proved the unsuitable nature of the material for an earthen bund. In this circular attention is drawn to the importance of testing a material for an earthen dam before construction. Two drawings of the work are appended.

*Agricultural Department.*

IRRIGATION. Department of Agriculture,  
Madras, Vol. IV, Bulletin No. 20.

Wood.

Notes of a series of lectures on Agriculture delivered at the Coimbatore College. This is an old publication first published in 1917. Describes sources of irrigation water, the methods of lifting water as used in Madras Presidency, the duty of water, the use of irrigation water, methods of field irrigation, and drainage of surplus water from the fields. Open surface drains and mole drains are described. Alkalinity of soils and methods of reclamation are discussed.

WATER HYACINTH. Department of Agriculture,  
Madras, Leaflet No. 38, 1933.

The weed is described and its evil effects are mentioned. The eradication of this weed wherever it is found is strongly urged. This plant has been classed as a noxious weed under the Agricultural Pests and Diseases Act of Madras.

BALUCHISTAN.

*Public Works Department.*

IRRIGATION SUMMARY OF PUBLIC WORKS IN  
BALUCHISTAN FOR THE YEAR 1936-37.

The irrigation works enumerated are non-productive. The total area irrigated is about 21,000 acres. The areas of principal crops irrigated and the working expenses are given. The major work completed was the protective bund in the Nari River and a diversion cut in the same river. A few other works were also carried out by the Department from funds other than irrigation funds. These include the Spin Karez reservoir project, a drainage project for improving water-logging conditions in Quetta, and a few roads and buildings. Irrigation works in the Nasirabad Tahsil are carried out by the Sind Irrigation Department.



## INDIAN STATES.

### BRIEF NOTE ON IRRIGATION IN CAMBAY STATE.

Cambay State being the draining ground of vast catchments to the North and East, irrigation tanks have been formed wherever natural basins occur. The largest of the tanks is Kenewal Tank having an area of about 2 sq. miles and a capacity of 171 million cu. ft. of water and is capable of irrigating 3,400 acres of land by means of distributaries 8 miles long.

There is also a catchwater drain, called the Alang Channel, running across the country. It intercepts the monsoon flood diverting it into 8 tanks along its now extant length of 8 miles and finally discharging into the Cambay Creek and thus scouring it and keeping it open for navigation. This channel is stated to have been constructed in times gone by for diverting the waters of the Sabarmati river for irrigation.

COPY OF A LETTER NO. 226, DATED 2ND APRIL 1937 FROM THE DIWAN OF JANJIRA STATE, REGARDING RESERVOIRS AND DAMS IN THE JANJIRA STATE.

There are no irrigation dams in the State but there are small dams on perennial nalas for the supply of drinking water to towns and villages. The largest of them is 80 ft. in length, 16 ft. high, 8 ft. wide at the base and 6 ft. wide at the top.

LIST SHOWING THE DAMS IN THE MUDHOL STATE WITH APPROXIMATE AMOUNT SPENT FOR CONSTRUCTION.

MYSORE AGRICULTURAL CALENDAR 1937.

Published by the Department of Agriculture, Mysore State.  
Contains notes on the following subjects :—

1. Effect of manuring on the quality of crops.
2. Some weeds which are the scourge of paddy land in Mysore and methods of control.
3. Some diseases of apples.
4. Sugarcane borer control by cultural methods.
5. Method of controlling some underground insect pests of crops.

Instructions on agricultural operations to be carried out each month are given in the form of monthly notes.

## BURMA.

*Public Works Department.*COMPLETION REPORT AND SCHEDULES OF THE  
SALIN CANAL REMODELLING PROJECT.

A very old irrigation system in Salin, Upper Burma, consisting of a bund of earth and stakes across a river and a canal taking out therefrom was replaced by a new irrigation project. The project consisted of a masonry weir across the river and a new system of canals. The works are briefly described, the financial prospects are discussed and schedules of expenditure are given.

MANUAL OF DEPARTMENTAL INSTRUCTIONS FOR  
THE GUIDANCE OF OFFICERS OF THE IRRIGATION  
BRANCH, PUBLIC WORKS DEPARTMENT,  
BURMA.

Contains rules for the guidance of officers and subordinate staff in the Irrigation Branch and rules for working and maintenance of various irrigation works.

*Association of Engineers in Burma.*PROCEEDINGS OF THE ASSOCIATION OF ENGI-  
NEERS IN BURMA, VOL. VIII, 1936.

## MAP-MAKING IN BRITISH GUIANA.

Slater.

A general account of surveying operations carried out in British Guiana in 1929.

EMERGENT REPAIR WORKS IN THE MEIKTILA  
IRRIGATION DIVISION.

Jackson.

The exceptionally heavy rains of 1935 resulted in floods of unprecedented magnitude causing widespread damage to irrigation works and to roads and railways. The peak flood discharge was 1,30,000 cusecs for a catchment of 240 sq. miles giving a value of 2,140 for 'C' in Dicken's formula. This is almost a record for the Indian Empire. In the U. S. A. there are cases of flood discharges in which the value of 'C' works out to 3,380 and 4,550. This paper describes the damage by floods to five irrigation works in the Meiktila Division and the repairs undertaken. Two of the works were reservoirs in which the earthen bunds breached and the escape weirs were damaged. The other three works are weirs. One of the weirs was so badly damaged that a new weir had to be built at a new site. In the two other weirs, the damages were confined to the divide walls, floor of the undersluices, and glacis of the weir. Model experiments were carried out at the

Ye-U Canal Division Hydraulic Laboratory to evolve the best form of divide wall, and to test the effect of a small concrete drop wall at the end of the glacis, followed by a horizontal floor having a dentated cill at its end. A most efficient arrangement of dentated cill was devised as the result of the investigations. Each of the five works is dealt with separately and detailed account of repairs carried out is given.

## EGYPT.

REPORT ON THE NAG HAMMADI BARRAGE, Naguib Bey Ibrahim.  
1927—1930. Ellison.

Gives details of design and construction of this barrage in Egypt. The chief features of the work were, use of sheet steel piling for the impervious floor, and piles for foundations cement grouting work in foundations and cableways for placing concrete. Some damage occurred to the permanent work during the 2nd year of construction by floods. The barrage has 100 bays of 6 metres each.

### ASSIUT BARRAGE REMODELLING :

CEMENTATION OF CUT-OFFS AT VENTS NOS. 13,  
39, 66 AND 93, NOVEMBER 1936.

The reasons for the provision of the cut-offs are described. Preliminary investigations to determine method of cementation are quoted (see page 131 of Bulletin No. 5). An emulsion consisting of bitumen and a patent chemical was used for cementation by means of injection pipes. The procedure of cementation is described. Tests were conducted to determine the effectiveness of the cementation. The cementation as carried out provided an efficient water-tight cut-off wall at the vents treated.

## CANADA.

*Department of Agriculture.*

USE OF IRRIGATION WATER ON FARM CROPS. Dominion of Canada, Deptt. of Agriculture Publication  
509, June 1936.

Palmer.

"The experiments reported in this treatise were conducted at the Dominion Experimental station, Lethbridge and were planned :—

- (1) To obtain information as to the stage of plant growth when water should be applied to field crops.
- (2) To study the value of fall irrigation.

- (3) To determine the number of irrigations required in different years by various crops.
- (4) To investigate certain phases of the inter-relations of soils, soil moisture, and plant growth.
- (5) To formulate standards of irrigation practice that will serve as a guide to farmers."

The experiments cover a period of from two to six years. A summary of conclusions based on the results of experiments is given at the end.

#### HYDRO-ELECTRIC PROGRESS IN CANADA IN 1936.

Describes hydro-electric progress in Canada in 1936. Very little addition was made to the total development of water power capacity but a number of developments are under construction. The total installation for the dominion at the end of the year amounts to 7,945,590 Horse Power. The principal activities during the year in the various provinces are described.

#### WATER POWER RESOURCES OF CANADA. No. 1933, March 1st, 1937.

This report presents a summarization of data and a brief discussion of the progress in the development and utilization of the water power resources of Canada. All existing stream flow and power data available have been systematically collated, analyzed and co-ordinated. The figures are based on rapids, falls, and power sites of which the actual head has been measured. The available water power is 20,347,400 H. P., and the total turbine installation is 7,945,590 H. P. Current year's progress in hydraulic plants is reviewed. Special reference is made to the contribution of water power to Canada's Central Electric Station, Mineral and Paper industries.

#### UNITED STATES OF AMERICA.

##### *Department of Agriculture.*

THE EFFECT OF CRAZY TOP DISORDER ON COTTON PLANTS AND ITS CONTROL BY IRRIGATION MANAGEMENT. Technical Bulletin No. 515, May 1936.

Hope.  
King.  
Parker.

SILTING OF RESERVOIRS. Technical Bulletin No. 524, July 1936.

Eakin.

The problem of silting of reservoirs is closely associated with problems of erosion control. The Soil Conservation Service of the U. S. A. instituted in 1934 an attempt at a general nation wide survey of the condition of reservoirs with respect to reduction of storage by silting. This publication

is the progress report on reservoir surveys by the Soil Conservation Service in 1934-35. These studies were undertaken with the object of collecting information on the factors involved in the silting of reservoirs and rates of silting, and to correlate the results with soil, slope, climatic conditions and land use. The work so far accomplished by the Soil Conservation Service consists of detailed surveys of silt accumulation in representative reservoirs in South Eastern, South Central and South Western areas.

The report outlines the more important aspects of the problem such as economic and physical aspects. The process of silting of reservoirs is described, and previous investigations of the problem are detailed. The field work and methods of survey by the Soil Conservation Service are then outlined and each survey undertaken and completed by the service is described in detail. The general conclusions drawn are that reservoir silting is widely prevalent and the chief contributory cause is erosion. Control of erosion and silt production is the only reliable method of preventing depletion of reservoir storage by silting. The book contains many maps and illustrations.

THE CHOICE OF CROPS FOR SALINE LAND. Circular  
No. 404, July 1936.

Kearney.  
Scofield.

This circular describes the constituents of the salts occurring in saline soils, the source of the salts and the effect of the salt constituent of soils on plant. It indicates cultural and irrigation methods to be adopted in dealing with saline soils, and names the plants which are most likely to succeed in them. Considerations governing choice of crops for saline lands are discussed. Some of the crop plants grown in the Western States are discussed in relation to their behaviour on saline soils.

*Department of the Interior, Bureau of Reclamation.*

TWENTY-FIRST ANNUAL REPORT OF THE RECLAMATION SERVICE, 1921-1922.

The report contains summary of construction results, summary of drainage works executed, details of power plants operated, and statements of financial details of the reclamation projects. The results of operations of projects completed by the Bureau of Reclamation are set forth and discussed. A description of project investigations carried out is given.

**TWENTY-FIFTH ANNUAL REPORT OF THE BUREAU OF  
RECLAMATION FOR THE FISCAL YEAR ENDED JUNE  
30, 1926.**

**TWENTY-EIGHTH ANNUAL REPORT OF THE COMMIS-  
SIONER OF RECLAMATION FOR THE FISCAL YEAR  
ENDED JUNE 30, 1929.**

**ANNUAL REPORT OF THE SECRETARY OF THE INTERIOR  
FOR THE FISCAL YEAR ENDED JUNE 30, 1933.**

Contains detailed reports of the various Bureaux, divisions, and offices of the Department of the Interior. The report of the Bureau of Reclamation gives the progress of the various projects under construction during the year, and discusses economic and engineering operations on other projects which are completed or partially completed. Investigations of prospective projects are also described.

**ANNUAL REPORT OF THE SECRETARY OF THE INTERIOR  
FOR THE FISCAL YEAR ENDED JUNE 30, 1934.**

The report of the Bureau of Reclamation describes construction activities on projects in progress. Economic and engineering operations on other projects are detailed.

The soil erosion service was established during the year to lay the foundation of a permanent national erosion control programme to meet the acute land crisis created by wasteful methods of land utilization. The first report of this service discusses the question of erosion control and sets forth the programme of work.

**ANNUAL REPORT OF THE SECRETARY OF THE INTERIOR  
FOR THE FISCAL YEAR ENDED JUNE 30, 1935.**

The report of the Bureau of Reclamation states that during the year the Bureau was engaged in the largest construction programme in its history. The Boulder Dam was completed during the year. Construction activities are described, and the working of the various projects with regard to agricultural returns and water supply etc. are given.

**ANNUAL REPORT OF THE SECRETARY OF THE INTERIOR  
FOR THE FISCAL YEAR ENDED JUNE 30, 1936.**

The report of the Bureau of Reclamation draws attention to the importance of the Bureau and the good work done. The report suggests that time has now come when serious consideration should be given to the control of floods of small streams. Construction activities of the Bureau are described and results of operations on some of the projects are set forth.

*University of California, Agricultural Experiment Station.***I. IRRIGATION EXPERIMENTS WITH PEACHES IN CALIFORNIA.****Hendrickson.  
Veihmeyer.****II. CANNING QUALITY OF IRRIGATED PEACHES.**

Bulletin No. 479, November 1929.

**Nichols.****WATER REQUIREMENTS OF COTTON ON SANDY LOAM SOILS IN SOUTHERN SAN JOAQUIN VALLEY.**

Bulletin No. 537, August 1932.

**Beckett.  
Dunshee.**

This bulletin presents the results of a five year study dealing principally with the irrigation requirements of cotton grown on the sandy loam soils and the effect of soil moisture deficiency on growth and yields.

**IRRIGATION EXPERIMENTS WITH PRUNES. Bulletin No. 573, May 1934.****Hendrickson.  
Veihmeyer.****MEASURING WATER FOR IRRIGATION. Bulletin No. 588, March 1935.****Christiansen.**

This bulletin describes the more common methods and devices used in measuring water for irrigation in California. The devices most commonly used, particularly in the small streams with which the farmer is concerned are weirs, orifices including adjustable and fixed submerged orifices, miner's inch boxes, Parshall flumes, commercial irrigation meters, and volumetric measurements. The various devices and their uses are described in detail and discharge tables are given showing discharges for different heads and crest lengths of weirs, and different cross sectional areas of orifices. The use of the Parshall measuring flume is discussed in detail, and standard dimensions of flumes from 3 to 9 inches throat width, and 1 to 10 feet throat width are given. The venturi tube is also described and tables are given to assist in solving equations for flow through venturi tubes. A concise statement of the hydraulic principles on which the methods of flow measurement are based, giving the various formulae applicable, is also included.

**SULFURIC ACID FOR CONTROL OF WEEDS. Bulletin No. 596, November 1935.****Ball.  
French.**

This bulletin describes experiments on the control of weeds by sulphuric acid spraying. The object of the experiments was to determine the percentage of the weeds destroyed and the yields. General conclusions are given regarding factors influencing the effectiveness of sulphuric acid as a weed spray, the effects of the treatment on the soil and the cereal plant, and wetting agents. The equipment for spraying developed in California is described.

**RECLAMATION OF WHITE-ALKALI SOILS IN THE IMPERIAL VALLEY.** Bulletin No. 601, July 1936.

Thomas.

Although a large part of the soil of the Imperial Valley is highly productive several thousand acres within it contain toxic amounts of soluble salts. In certain areas the salts were present in the surface before irrigation was started in the valley, but much of the land which at the outset was free from salt accumulation, shows excessive amounts of salts after several years of irrigation. Irrigation and seepage water has saturated the subsoil and caused a rise in the ground water level. A survey of alkali conditions in the Imperial Valley shows high concentrations of white alkali. An alkali reclamation experiment has been carried out in a typical area where alkali has accumulated on account of poor drainage. The treatment consisted of applying gypsum, sulphur and manure to the soil, the use of a plant tolerant to alkali as a green manure, and leaching. The experiments show that it is possible to reclaim the soil by leaching alone without special treatment with gypsum or sulphur.

**SOLAR ENERGY AND ITS USE FOR HEATING WATER IN CALIFORNIA.** Bulletin No. 602, November 1936.

Brooks.

In California, direct use of solar energy as heat is now being made by several thousand solar water heaters. A theoretical discussion of the nature and the availability of solar energy, and its absorption by different surfaces is given. The solar water heater is then described. Some forms of solar water heater systems and their construction are explained.

**ALKALI SOILS.** Circular No. 292, June 1925 (Re-printed March 1931).

Hibbard.

The purpose of this circular is to present in brief the best available information on the subject of Alkali soils in respect to their origin, nature effects, examination, treatment, and cropping. The circular is in the form of a questionnaire with replies to clarify the various issues raised.

**DRAINAGE ON THE FARM.** Circular No. 304 (Re-printed December 1930).

Weir.

This circular describes the principles and methods of drainage of wet lands in California. Almost every farm contains some land that could be improved and made to produce more or better crops by some type of drainage. The object of drainage is to remove free water existing in the soil in excess of that necessary for plants. Two types of drains are in use for farm drainage, namely the open drain and the tile drain. The author considers tile drains to be more efficient. Design and construction of open and tile drains and their maintenance are dealt with in detail.



**IRRIGATION OF ORCHARDS BY CONTOUR FURROWS.**

Agricultural Extension Service Circular No. 16,  
April 1928 (Revised September 1932).

Huberty.  
Brown.

Contour planting of orchards is a common practice in California. The method consists of planting trees along a grade contour. The water distribution system consists of a main pipe or flume placed at right angles to the contours. Water is delivered from this pipe line to the tree rows which are on graded contours by means of hydrants or other similar device. This bulletin describes the method of laying out a system of contour planting and the irrigation of orchards planted according to this method.

**ESSENTIALS OF IRRIGATION AND CULTIVATION OF ORCHARDS.** Agricultural Extension Service Circular No. 50, December 1930 (Revised September 1936).

Veihmeyer.  
Hendrickson.

This circular briefly summarizes results of experiments on the irrigation and cultivation of deciduous orchards.

**COMMERCIAL FERTILIZERS AND SOIL FERTILITY IN CALIFORNIA.** Agricultural Extension Service Circular No. 57, October 1931 (Reprinted June 1933).

Hibbard.

A commercial fertilizer is a material which supplies one or more of the three elements, nitrogen, phosphorus and potassium. This circular gives information about commercial fertilizers and their effect on soils. The functions of nitrogen, phosphorus and potassium in plant nutrition are described. The need of fertilizers, procedure of selection of a suitable fertilizer, and methods of applying fertilizers are mentioned. Names of commercial fertilizers commonly used and their prices are given.

**THE CONTOUR CHECK METHOD OF ORCHARD IRRIGATION.** Agricultural Extension Service Circular No. 73, March 1933.

Brown.

Contour checks are irregular basins formed by small levees or ridges located on level contours. The usual interval in elevation between contours is 2.4 inches. The ends of the contour levees are joined at the boundary of the tract by an enclosing levee. The position of the contour levees or ridges are determined by an engineer's level. Conditions under which this method may be used, description of the method, advantages and disadvantages of the method and instructions for laying out and designing a system of contour checks are contained in this bulletin. A brief description is also included, by types, of ridging equipment and machinery.

*University of Iowa.*

**THE FLOW OF WATER THROUGH CULVERTS.**  
Studies in Engineering Bulletin No. 1, New  
Series No. 103, February 15, 1926.

Yarnell..  
Nagler..  
Woodward.

This bulletin presents the results of 3,301 experiments on the flow of water through short conduits such as pipe and box culverts and sluice ways under levees. The object was to determine the quantity of water that will flow through culverts of different materials and sizes, under actual working conditions. Methods of making the tests are described and the experimental results are discussed. The conclusions drawn from the tests are set forth. Velocity distribution curves through pipe culverts are given and discharge formulae for culverts have been developed.

**LABORATORY TESTS ON HYDRAULIC MODELS OF THE  
HASTINGS DAM.** Studies in Engineering Bulletin No. 2, New Series No. 230, July 1, 1932.

Nelson.

The Hastings Dam was constructed across the Mississippi at Hastings with the object of developing a deeper navigable waterway on the upper Mississippi. The Hastings dam project is the initial unit in a plan contemplating the provision of a series of slack water pools formed by permanent low head dams across the river. The dams will be built upon unstable alluvial foundations. A model study was made of the behaviour of the Hastings Dam under simulated operating conditions with a view to study erosion effects below the dam, to suggest improvements in the design, to determine coefficients for the spillway section, and to determine the best scheme of operation. The study was also conducted with a view to apply them in the design of other dams of the project. The studies carried out are described in this bulletin. The general results obtained from the studies are set forth in the introductory part of the bulletin. The features of the project, and the hydrology of the watershed are described, and the theoretical principles governing the use of hydraulic models are discussed. The actual models used are then described and the problems studied are given in detail.

**TESTS OF ANCHORAGES FOR REINFORCING BARS.**  
Studies in Engineering Bulletin No. 3, New  
Series No. 257, August 15, 1933.

Posey..

Special anchorages for the ends of reinforcing bars are almost universally used in reinforced concrete construction. This bulletin reports results of tests carried out by the writer on various types of anchorages. The tests were conducted with the object of finding an anchorage giving the high.

ultimate values of spirally reinforced hooks but without their tendency to excessive slip. The writer states in conclusion that the most satisfactory anchorage tested during the 4 years covering the investigation was a straight embedded plain round bar the surface of which had been roughened by rows of indentations made with a blunt cold chisel.

- A SUMMARY OF HYDROLOGIC DATA RALSTON CREEK WATERSHED, 1924-1935.** Studies in Engineering Bulletin No. 9, New Series No. 328, December 1936.

Mavis.  
Soucek.

This bulletin presents a detailed summary of data pertaining to rainfall, run-off and ground water levels of the Ralston creek watershed, a drainage area of three square miles outside Iowa city.

- FLOW CHARACTERISTICS IN ELBOW DRAFT TUBES.** Studies in Engineering Reprint No. 1, New Series No. 333, May 1, 1937.

Mockmore.

This is reprinted from the Proceedings of the American Society of Civil Engineers February 1937. See page 103 of Bulletin No. 5.

- REPORT ON HYDRAULICS AND PNEUMATICS OF PLUMBING DRAINAGE SYSTEMS—I,** Studies in Engineering Bulletin No. 10, New Series No. 334, May 15, 1937.

Dawson.  
Kalinske.

- AN INVESTIGATION OF SOME HAND MOTIONS USED IN FACTORY WORK,** Studies in Engineering Bulletin No. 6, New Series No. 301, June 15, 1935.

Barnes.

- RADIATION INTENSITIES AND HEAT-TRANSFER IN BOILER FURNACES,** Studies in Engineering Bulletin No. 8, New Series No. 323, July 1936.

Croft.  
Schmarje.

*Kansas Agricultural Experiment Station.*

- SOIL MOISTURE AND WINTER WHEAT WITH SUGGESTIONS ON ABANDONMENT.** Bulletin No. 273, January 1936.

Hallsted.  
Mathews.

In regions of low rainfall, the yield of wheat is more or less dependent on the moisture content of the soil at seeding time. A knowledge of the effect of moisture content at seeding on the yield is a valuable guide to the farmer in deciding whether the crop should be abandoned in the early stages to avoid harvesting at a loss. Studies on the effect of moisture content at seeding on yield were conducted at a number of places and the results are published in this bulletin. The results are discussed and conclusions given at the end.

*Oklahoma Agricultural Experiment Station.*

SCIENCE SERVING AGRICULTURE : REPORT OF THE  
DIRECTOR, AGRICULTURAL EXPERIMENT STATION  
FOR JUNE 1, 1934 TO JUNE 30, 1936.

Blackwell.

Contains report on insect pest studies, horticultural investigations, soils and crops investigations, plant diseases, and other matters connected with agriculture and animal husbandry.

*Panhandle Agricultural Experiment Station.*

WATER SURVEY OF TEXAS COUNTY, OKLAHOMA.  
Bulletin No. 20, October 1930.

Houghton.

This bulletin presents results of a well water survey of Texas County of Oklahoma. The object of the survey was to determine whether sheet water exists in the counties, its source and abundance, its chemical nature, purity, and possible uses for household and agriculture. The procedure was to take samples in each township of the county, to collect information about depth of water, and to analyse the chemical and physical properties of the water collected from the wells. The method of chemical analysis is dealt with in detail and the effect of the presence of chlorine, nitrogen, phosphorus, potassium etc. in water is discussed.

WATER SURVEY OF CIMARRON COUNTY, OKLAHOMA.  
Bulletin No. 38, May 1932.

Houghton.

This bulletin presents results of a well water survey of Cimarron County of Oklahoma, on the same lines as the well water survey of Texas county.

RESULTS OF LEVEL TERRACING ON HEAVY SILT LOAM  
SOIL. Bulletin No. 53, March 1934.

Finnell.

Results of experiments on level terracing on heavy silt loam soil in Oklahoma with a view to determine the actual gains in soil moisture supplies accruing from the retention of run-off by terraces are given in this bulletin. Grain yields from terraced plots of various widths and untterraced plots are compared. Soil moisture determinations were made in order to find out the actual increase in soil moisture due to terracing and it was found that the increase varied from 0 to 55.4 per cent. of the available moisture. The average increase in yield worked out to 32.6 per cent. of the average untterraced yield.

*Utah Agricultural Experiment Station.***WATER TABLE VARIATIONS : CAUSES AND EFFECTS.**

Bulletin No. 144, May 1916.

Ballantyne.

A study was made of the effect of rainfall and irrigation water on the soil in relation specially to its free water content at various seasons, on the Utah Experiment Farm. The soil of the farm is sandy, specially below the first foot. Seepage conditions appeared on the farm and it became necessary to investigate ground water conditions. Seven wells were bored at different points on the farm, and the depth to water in them was measured for a period extending over 4 years. The measurements were taken bi-weekly at first, and bi-monthly afterwards. Irrigation and precipitation were noted as they occurred. Graphs showing depths observed during 3 years for all the wells have been included and the causes of variation of depths are discussed. Effect of irrigations on the depths is discussed in detail. The effect of the variation in depths on vegetation is also considered. Remedies to rectify the seepage conditions are suggested. The economical use of irrigation water is very important in preventing these seepage conditions. Conclusions arrived at are :

1. The level of free underground water went down through the action of natural drainage, surface evaporation and growing vegetation.
2. Normal rainfall caused a rise in the level depending on the distance of free water from the surface.
3. Long continued irrigation caused a rise in the level.

**IRRIGATION EXPERIMENTS WITH SUGAR BEETS.** Bulletin No. 186, September 1923.

Harris.  
Pittman.

Results of an experiment on the irrigation of sugar beets continuing over five years are reported in this bulletin. The experiments consisted of applying irrigation water at different times and in different amounts and noting the yield, and sucrose content of the beet crop produced. Some of the conclusions are summarized below.

1. Where a limited quantity of water was used, larger yields were obtained by applying it in several small irrigations rather than in fewer large irrigations.
2. As long as the irrigation was confined to the season between two weeks after thinning and a month before harvest time, its distribution had little effect on the sugar content or purity of the beets.

**MUTUAL IRRIGATION COMPANIES IN UTAH. Bulletin No. 199, May 1927.**

Hutchins.

The mutual irrigation company is defined as a private association of water users, either incorporated or unincorporated, the purpose of which is to obtain and distribute water at cost to the lands of members only. A number of mutual irrigation companies are in existence in Utah and three-fourths of the irrigated land of Utah receives water through the agency of these companies. This bulletin presents the results of a study of the history, operation, and utility of mutual irrigation companies in Utah.

**DRAINAGE AND IRRIGATION, SOIL, ECONOMIC, AND SOCIAL CONDITIONS, DELTA AREA, UTAH: DIVISION 1—DRAINAGE AND IRRIGATION CONDITIONS**

Bulletin No. 255, April 1935.

Israelsen.

In recent years many drainage and irrigation projects in the U. S. A. have been confronted with serious financial difficulties. A study of factors influencing the financial condition of certain Utah irrigation and drainage projects has been conducted since 1928 under four different heads, namely, engineering and engineering economics, soil productivity, sociological and economic aspects. This bulletin reports the findings and conclusions under the first head. Three other bulletins reporting the findings under the three remaining heads will be published later. In an introduction the author discusses in general some causes of the financial difficulties of American drainage and irrigation projects. A brief history of drainage and irrigation in the Delta area, Utah, is given. The investigations include study of the design and functioning of drainage systems and their effect on soil alkalis, irrigation water needs, and the problem of culturable land lying idle. Changes in the present policy of drainage and irrigation affairs in Utah are suggested. Finally, conclusions arrived at from the investigations are summarized.

**DRAINAGE AND IRRIGATION, SOIL, ECONOMIC, AND SOCIAL CONDITIONS, DELTA AREA, UTAH: DIVISION 2—SOIL CONDITIONS. Bulletin No. 256. May 1935.**

Jennings.  
Peterson.

This is the second of a series of 4 bulletins reporting the findings and conclusions of an investigation into the factors influencing the financial condition of certain Utah irrigation and drainage projects. This bulletin contains a study of soil conditions in the Delta area, Utah. Topography of the area is given, soils of the area are described and classified, soil properties, physical and chemical, are discussed, and ratings of the soil types for agricultural purposes are given. Conclusions arrived at from the investigations are given at the end.

DRAINAGE OF LAND OVERLYING AN ARTESIAN GROUND-  
WATER RESERVOIR : FINAL REPORT. Bulletin No.  
259, November 1935.

Israelsen.  
McLaughlin.

This bulletin constitutes a final report of some phases of co-operative drainage studies in Cache Valley, Utah. Waterlogging and alkali accumulation in several tracts of the Cache Valley which overlies an artesian groundwater reservoir, occurred some time ago and investigations were continued for a number of years with a view to acquire knowledge concerning the causes of waterlogging and its prevention. Progress of the work was reported in bulletin 242 and the present bulletin contains the final report of the investigations. Conclusions are summarized at the end.

SOIL-MANAGEMENT AND CROP-PRODUCTION STUDIES.  
Bulletin No. 270, February 1936.

Zobell.

Carbon County district is one of the largest and best coal producing districts in the State. In 1927 an experimental farm was established in Carbon County, in a region where the agricultural resources had only been partially developed. This bulletin is a résumé of agricultural conditions and operations studied at the experimental farm. General character of the soils, alkali problems, erosion problems, irrigation and drainage conditions, cultural methods, crop testing experiments, and fertilizer tests are described and discussed.

ROTATIONS AND CROPPING SYSTEMS. Circular No.  
103, April 1934.

Pittman.

A proper cropping system is of great importance in securing the maximum efficiency in farm management. The selection of a proper cropping system is based on maximum returns from the farm that can be secured without impairing the fertility of the soil. Some of the more important cropping systems, their limitations, their advantages and disadvantages are discussed in this bulletin. There are in the main three cropping systems, the continuous system in which only one crop is grown continuously on the same land for a great many years; the rotation system in which crops are sown in a regular sequence which is repeated, and the 'opportunistic' system in which no rules are followed and crops are changed as often as necessary in a haphazard manner. The features of these systems and the advantages and disadvantages of each are discussed.

## AUSTRALIA.

*Council for Scientific and Industrial Research.*

- A SOIL SURVEY OF BLOCK E (REMARK) AND RAL  
RAL (CHAFFEY) IRRIGATION AREAS. Bulletin No.  
42, 1929.

Taylor.  
England.

Presents results of soil survey of the areas. The methods of field work and laboratory work are described.

- A SOIL SURVEY OF THE WOORINEN SETTLEMENT,  
SWAN HILL IRRIGATION DISTRICT, VICTORIA.  
Bulletin No. 45, 1930.

Taylor.  
Penman.

This bulletin describes the soil types occurring in the Woorinen Settlement in Swan Hill Irrigation District, and records results of field and laboratory studies of the soil in that area.

## INVESTIGATIONS ON IRRIGATED PASTURES.

1. THE YIELD AND BOTANICAL COMPOSITION OF AN  
IRRIGATED PERMANENT PASTURE UNDER VARIOUS  
SYSTEMS OF PASTURE MANAGEMENT.

Richardson.

2. THE CHEMICAL COMPOSITION OF IRRIGATED PAS-  
TURES AT WOOD'S POINT, SOUTH AUSTRALIA.  
Bulletin No. 71, 1932.

Gallus.

The investigations recorded in the first paper were conducted on reclaimed swamp soil along the lower reaches of the Murray river. In the second paper the effects on the chemical composition of the pasture soil of the various modes of pasture treatment are described.

- THE ESTABLISHMENT, PERSISTENCY, AND PRODUC-  
TIVITY OF SELECTED PASTURE SPECIES ON AN IRRI-  
GATED RECLAIMED SWAMP. Bulletin No. 80, 1934.

Trumble.  
Davies.

This bulletin gives an account of the preliminary and explanatory work involving trials of species, strains, and mixtures of herbage plants suitable for an irrigated reclaimed swamp.

- THE CO-OPERATIVE DEVELOPMENT OF AUSTRALIA'S  
NATURAL RESOURCES. Pamphlet No. 3, 1923.

Lightfoot.

This pamphlet explains the need of further development of Australia's natural resources, and indicates the lines along which such development is possible.

- METHODS FOR THE EXAMINATION OF SOILS. Pam-  
phlet No. 8, 1928.

Prescott.  
Piper.

This pamphlet describes methods of soil analysis in detail. Field methods, preparation of samples, mechanical analysis, and chemical analysis are discussed in detail.



THE MECHANICAL ANALYSIS OF SOILS. Pamphlet  
No. 13, 1929.

Piper.  
Poole.

In this pamphlet details are given of the alterations necessary to bring the method for the mechanical analysis of soils as developed at the Waite Agricultural Research Institute, Australia, into line with a recently developed international method. A number of soils have been analysed according to the old and new standards, and the method of interpolation of results from one system to the other is illustrated.

THE IRRIGATION OF HORTICULTURAL COMMUNITY  
SETTLEMENTS. Pamphlet No. 26, 1932.

Lyon.

The Murray Valley irrigation settlements are horticultural settlements. This pamphlet contains an account of investigations into existing irrigation practices in these settlements with a view to find out the defects in these practices. Suggestions are made regarding the initiation of corrective measures.

THE PREVENTION OF DECAY IN BUILDING FOUNDATIONS. Trade Circular No. 18, 1933.

The decay of timber in floors, joists, bearers, linings, etc., is a source of great loss in ordinary residences. Timber decays because it is not properly handled, used, or protected. This circular describes types of decay, conditions favourable to its development, and spread of decay. Precautions to be taken in preventing decay are set forth in detail. Steps to be taken to eradicate dry rot from buildings are described.

## INTERNATIONAL CONFERENCES, ETC.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE  
ON SOIL MECHANICS AND FOUNDATION ENGINEERING,  
VOLS. I, II AND III.

The Conference was held from June 22 to 26, 1936 at the Graduate School of Engineering, Harvard University, U. S. A. Vols. I and II contain papers contributed to the Conference. Vol. III contains the Secretary's report describing the purpose of the Conference and its organization and the meetings and other events of the Conference, addresses by the President and other members, discussions on the papers presented, and a few additional contributions of special merit. The papers are grouped under the following sections.

Section A.—Reports from Soil Mechanics laboratories on testing apparatus, technique of testing, and investigations in progress.

**Section B.—Exploration of soil conditions and sampling operations.** Papers under this section describe the procedure of exploration, sampling and testing of soils as practised in different countries.

**Section C.—Regional soil studies for engineering purposes.**

**Section D.—Soil properties.**—A few papers under this section may be mentioned.

1. Shearing resistance of soils.
2. Improved methods of consolidation tests and of the determination of capillary pressure in soils.
3. The chemical nature of soils.
4. Shearing resistance of saturated soils, and the angle between the planes of shear.
5. Report on an investigation of shearing resistance of cohesionless soils.

**Section E.—Stress distribution in soils.** A few of the papers under this section are :—

1. The stress distribution round a pile.
2. Tangential stresses under a spread foundation.
3. A rational method for the determination of the vertical normal stresses under foundations.
4. A method of representing the distribution of stress in ground.
5. Stress distribution in elastic solids.

**Section F.—Settlement of structures.** Most of the papers in this section describe settlement observations of a number of structures, and the nature of the foundations of these structures. Conclusions drawn are set forth at the end of some of the papers as regards the causes of the settlement. In some papers the measures taken to prevent further settlement are described. Some of the papers are as follows :—

1. Settlement observations of buildings in Egypt.
2. Movements of building footings due to earthquake loads.
3. Settlement records of the Mississippi river bridge in New Orleans.
4. A case of bridge abutment movement.
5. A case of settlement of a bridge pier.
6. Direct measuring of internal water pressures in clay.
7. Foundation soil testing and settlement measuring.
8. **Securing a Vienna house against injurious settlement by reducing the soil pressure and draining the underground.**

Section G.—Stability of earth and foundation works, and of natural slopes. In this section the following papers are included :—

1. Stability of foundations of embankments.
2. Stability of earth slopes.
3. The control of landslides.
4. Determination of groundwater tensions, a necessary element in investigating the stability of slopes.
5. Critical height and factor of safety of slopes against sliding.
6. Stability of slopes of natural clay.

All these papers present a mathematical treatment of the subject dealt with. Formulae have been derived for use in design. The other papers in this section are :—

7. Bankslides in the Whangpoo river.
8. Foundation investigations of Fort Peck Dam closure section.
9. Uplift pressure on weirs of simple and complex designs :  
This paper is contributed by Dr. McKenzie-Taylor and Dr. Vaidhianathan of Punjab Irrigation Research Institute and is the only Indian contribution. The paper describes investigations of uplift pressure on weirs with flush and depressed floors and one sheet pile.

Section H.—Bearing capacity of piles. Amongst the papers in this section may be mentioned :—

1. Pre-determination of the required length and prediction of toe resistance of piles.
2. Conditions for the stability of piles.
3. Dynamic formula for determining resistance of piles.

Section I.—Pile loading tests.

Section J.—Earth pressure against retaining walls, excavation sheeting, tunnel linings, etc. Some of the papers in this section are :

1. Distribution of normal pressure on a retaining wall due to a concentrated surface load.
2. Distribution of the lateral pressure of sand on the timbering of cuts.
3. A fundamental fallacy in earth pressure computations. This paper by Dr. Terzaghi discusses Rankine's and Coulomb's theories of earth pressure which were the basis of earth pressure computation until now. He proceeds to show that Rankine's theory is no longer acceptable and Coulomb's theory has its limitations.

**Section K.** Groundwater movement and seepage. The following papers were contributed in this section :—

1. Electric investigation of underground waterflow nets.
2. On the steady flow of water percolating through soils with homogeneous anisotropic permeability.
3. Seepage under an earth dam.
4. The law of distribution of moisture in soils and methods for the study of same.

**Section L.**—Soil problems in highway engineering including frost action on soils. Papers in this section describe methods of foundation dehydration and stabilization of fills, methods of treatment of compressible soils for heavy traffic conditions, methods of group classification of soils in highway work, field testing of soils and soil survey. The following are some of the papers :—

1. Experimental road for heavy traffic on a very compressible soil.
2. Vertical and lateral displacement of a reinforced concrete culvert under a high earth embankment.
3. Studies of fill construction over mud flats including a description of experimental construction using vertical sand drains to hasten stabilization.

**Section M.**—Methods for improving the physical properties of soils for engineering purposes including recent developments in constructing and compacting earth fills. There are four papers under this section :—

1. A new method of impermeabilizing and improving the physical properties of previous subsoils by injecting bituminous emulsions. This paper describes a process of making fine water-bearing sandy soils permanently impermeable by injecting a special bitumen emulsion under moderate pressure into the soil.
2. Earth embankments for the Pickwick Landing Dam. This is a dam under construction by the Tennessee Valley Authority. The hydraulic fill construction and other features are described.
3. Electro-chemical hardening of clay soils. A new method, still in the course of development, of hardening clay deposits by electro-chemical process is described.
4. Soil consolidation works effected near Elne, France, on a bridge over the Tech River. This paper describes strengthening of pier foundations by cement injection.
5. Comparative studies of the effectiveness of different methods for compacting cohesionless soils.

**Section N.—Modern methods of design and construction of foundations.** Most of the papers of this section describe the geology of the foundations and special construction of the foundations of some large works. One paper deals with various types of cofferdam construction. A few of the papers are mentioned below :—

1. Foundation for palace of Soviets : designing a rigid heavy foundation on compressible materials through the use of soil mechanics.
2. Some features in connexion with the foundation of the Svir 3 hydro-electric power development.
3. A special foundation method for bridge piers adopted in Danish fjords.
4. The floating foundation of the new building for the National Lottery of Mexico.
5. Failure of bridge piers due to scour.
6. Concrete filled steel cylinders for foundations.
7. Cofferdams.

**Section Z.—Miscellaneous.**—The papers in this section likely to be of interest are given below :—

1. Soil mechanics as a practical science.
2. Field investigations of the theory of vibration of massive foundation under machines.
3. Consolidation of marine clay.
4. Experiment with models for determining the deformation and tensions in foundations on plastic ground.
5. Foundations and embankments of Quabbin dams.
6. Improved soil testing methods.
7. A preliminary investigation into the subject of foundations in the 'black cotton' and 'kyatti' soils of Mandalay district in Burma.

LIST OF MEMBERS OF THE PERMANENT INTERNATIONAL ASSOCIATION OF NAVIGATION CONGRESSES, NOVEMBER 1936.

BULLETIN OF THE PERMANENT INTERNATIONAL ASSOCIATION OF NAVIGATION CONGRESSES, No. 23, JANUARY 1937.

CHARACTERISTICS OF COHESIONLESS SOILS AFFECTING THE STABILITY OF SLOPES AND EARTH FILLS.

Casagrande.

The writer discusses the meaning of the term stability, the relation between stability and shearing resistance, the shearing resistance of cohesionless soils, and the volume changes associated with the deformation of soils during shearing tests. The effect of volume changes during deformation on stability is considered, and effect of disturbances on the

stability of cohesionless soils is illustrated by means of some experiments. Methods for compacting cohesionless soils are discussed. The conclusions of the writer are :

1. Every cohesionless soil has a certain critical density in which state it can undergo any amount of deformation without volume change. If the soil is below critical density it can stand any disturbance without danger of flow or slide.
2. The density of many cohesionless soils is above the critical density. Such materials change in volume if subjected to deformation, causing slide.
3. Cohesionless soils above critical density can be efficiently compacted and stabilized by special vibration machinery.

#### THE PROBLEM OF RIVER-BORES.

Masse.

The principal aspects of the phenomenon of tidal bores in rivers are set forth, and an explanation of the cause of the phenomenon is put forward. A theoretical study of tidal bore phenomena is made based on fluvial hydrodynamics. Two laws governing the occurrence of bores are derived as a result of the theoretical analysis of the problem.

#### THE CLASSICAL THEORY OF EARTH PRESSURE.

Jaky.

A study of earth pressure theories offering a solution of the problem of earth pressure on the basis of a curved sliding slope for cohesionless soils. The existing earth pressure theories of Coulomb and Rankine are reviewed and their deficiencies are pointed out. Earth pressure with a curved sliding slope is discussed, and an equation for the sliding slope is evolved. Graphical solutions of this equation are given.

#### REPORT ON THE SECOND INTERNATIONAL CONGRESS FOR BRIDGE AND STRUCTURAL ENGINEERING HELD IN BERLIN AND MUNICH FROM 1ST TO 11TH OCTOBER 1936.

Whishaw.

Major W. B. Whishaw, R.E., attended the Congress as the representative of the Government of India. In this report he describes in brief the proceedings, and gives a brief account of the works he visited in Germany, which include a number of bridges, modern roads with concrete trackways, and the test house in Berlin. He brings to notice a few interesting developments which include steel houses, reinforced concrete shell roof construction of hangars, and pre-stressed reinforcement in the manufacture of piles, columns, inverts, walls, beams, arches, pipes and roads.

The papers read at the Congress are arranged under different themes. Summaries are not given, but conclusions under the different themes are recorded. The themes are as below :—

1. Importance of the toughness of steel for calculating and dimensioning steel structural work. 8 papers.
2. Stressing and degree of safety in reinforced concrete structures from the designer's point of view. 10 papers.
  - (a) Influence of stationary and repeated loading.
  - (b) Means for increasing the tensile strength of concrete.
  - (c) Use of high tensile steel.
  - (d) Influence of concreting and dilation joints.
3. Practical questions in connection with welded steel structures. 25 papers.
4. Recent points of view concerning the calculation and design of bridge and structural engineering in reinforced concrete. 10 papers.
  - (a) Walled structures.
  - (b) Wide span bridges.
5. Theory and research work on details for steel structures of welded and rivetted construction. 12 papers.
6. Concrete and reinforced concrete in hydraulic engineering.  
The following papers are mentioned under this head :—
  - (a) Development and analysis of arch Dams. (German).
  - (b) The use of concrete in construction of solid dams. (French).
  - (c) Reinforced concrete piles during driving. (English).
  - (d) Use of concrete in dam construction in Germany. (German).
  - (e) Reinforcements of pressure pipes for the Mareges plant. (French).
7. Application of steel in bridge and structural engineering and in hydraulic construction. 14 papers.
8. Research concerning building ground : soil studies and soil tests. 4 papers.

MINUTES OF PROCEEDINGS OF THE MEETING OF THE  
SUB-COMMITTEE ON SPECIAL CEMENTS OF THE IN-  
TERNATIONAL COMMISSION ON LARGE DAMS, HELD  
IN LONDON ON THE 16TH APRIL 1937. (In French).

The following are some of the questions dealt with :—

1. Methods of testing (a) Permeability, (b) Action on cement on water filtering through concrete, (c) Heat of hydration.
2. Shrinkage of mortar and concrete.
3. Methods of testing the action of Pozzuolana.
4. Methods of measuring the fineness of cements.
5. Text of an industrial specification for cement for dams.

## OTHER PUBLICATIONS.

**THE NATIONS WATER SUPPLY.** (The publication is available in the Imperial Secretariat Library and not in this office).

Walters.

This is an interesting book recently published containing a general description of the sources of water supply in Great Britain and the factors affecting them. The book is divided into eight sections of which the first three are of a general nature and of universal interest.

The first section deals with rainfall in relation to water supply. In Great Britain the flow of streams is estimated from rainfall observations and not by actual measurements of river discharges as in America. The average rainfall over a period of 35 years is generally used in England for determining run-off and flow of streams. It is estimated that the net loss of rain water from evaporation, absorption and other causes varies from 13 inches to 20 inches per year according to nature of soil.

The second section deals with geology in relation to water supply. The importance of a full knowledge of the geology of sites for locating dams is stressed. Instances of failures of dams due to faulty locations are given.

Section three deals with the chemical qualities of water in reservoirs and the subsoil. Hard and soft waters, softening hard waters and contamination of water are discussed.

Sections 4 and 5 describe the water resources, upland and underground, that have been developed in Great Britain and comprise the water supply schemes of some of the important towns and counties. Section 6 describes a few **typical river installations** for water supply.

Section 7 gives a short history of the origin and growth of water undertakings and the sequence of legislation on water supply up to the present day.

Section 8 describes in **outline some engineering works** appurtenant to water supply schemes, such as impounding reservoirs, wells, boreholes, pumping machinery etc.

**NOTE ON THE POLICY OF IRRIGATION IN INDIA WITH PARTICULAR REFERENCE TO FUTURE DEVELOPMENT AND FINANCE.**

Curry.

With an ever increasing population and improved methods of treating diseases and epidemics, an increase in the growth of food crops is vitally necessary in India. The note indicates the lines along which an increase in the area under crops can take place. Linked with the question of



increasing the area under crops is the question of increasing facilities for irrigation. In Provinces where cold weather discharges are fully utilized, further developments are only possible through increased use of flood season supplies, storing flood water, lift irrigation from rivers during the flood season by electricity or otherwise, and by improving the efficiency of old inundation canals. Reclamation of water-logged areas by drainage and pumping is necessary to increase area under crops. Conditions in Bengal are discussed, and it is stated that in years of drought, crops suffer very much. Impounding reservoirs are necessary to make water available in drought seasons. For deltaic areas a policy of reclamation of low areas should be initiated. In view of the indirect returns from irrigation projects the present criterion of 6 p.c. return on outlay for a profitable project should be reduced to 3 or  $3\frac{1}{2}$  p.c. Increasing the fertility of the soil is also closely connected with the problem of increasing area under crops. Means of increasing fertility are discussed.

NOTE NO. 43 OF JANUARY 1937, ON AFFLUX  
EXPERIMENTS WITH A MODEL OF A WEIR FOR  
THE ALANDI WATER SUPPLY PROJECT—CARRIED  
OUT AT THE HYDRODYNAMIC RESEARCH STATION  
AT LAKE FIFE, POONA.

Describes the experiments to determine afflux in a weir with models of different profiles, and presents the results. The dynamic force acting on the weir has been worked out mathematically.

LETTER DATED 17TH MAY 1937, FROM MR. C. C.  
INGLIS, TO MR. M. R. RICHARDSON, REGARDING  
EXPERIMENTS TO ASCERTAIN THE BEST METHOD  
OF PROTECTING THE DOWNSTREAM PAVEMENT OF  
SARDA BARRAGE AT BANBASSA.

Mr. Inglis states that in all experiments comparing arrows with deflector-baffle design, arrows have been found inferior for dissipating energy and safeguarding structures. No experiments have so far been done to determine the effect of the slope deflector during the break up of the talus. In connection with the Sarda Barrage investigations, further experiments will be carried out on this question. In connection with the Bhimgoda weir in the United Provinces it has been decided to allow the loose talus to scour down to a slope of 1 in 3 before taking any action. Mr. Inglis considers this policy dangerous and has given reasons in support of his opinion.

LETTER DATED 21ST MAY, 1937, FROM MR. C. C. INGLIS, TO THE EDITOR, ENGINEERING NEWS-RECORDS, NEW YORK, REGARDING CLOUDBURST FLOOD FORMULA BY GUTMAN.

Mr. Gutman evolved a formula for discharge of Cloudburst floods for limited areas of 1 to 70 sq. miles. (See page 52 of Bulletin No. 4). Two other commentators considered this formula incorrect as it gives flows far below those actually observed in Texas. Mr. Inglis has given another formula suitable for all catchments which agrees with Gutman's formula fairly well. This formula has the merit of being applicable to all discharges and not limited discharges as the Gutman formula. Mr. Inglis considers the Texas floods of unusual magnitude and the figures differ so markedly from the rest of the world that they are of no importance outside the area.

A MEASURING DEVICE FOR IRRIGATION EXPERIMENTS. (REPRINTED FROM SCIENTIFIC AGRICULTURE, JULY 1936).

Fleming.

Describes a device for measuring irrigation water applied to individual rows. This device may be used where water can be delivered into it by stand pipe or hose or by gravity from a carrier flume at least 2 ft. above the ground. The water is measured in gallons.

LETTER NO. 175, DATED 20TH MAY 1937, FROM MR. INGLIS TO MR. MURCHANDANI REGARDING SPIN KAREZ RESERVOIR PROJECT.

Mr. Inglis examined the data of the Spin Karez Reservoir Project (See page 13 of Bulletin No. 3) for the water supply of Quetta. The slope of the Spin Karez river approximates 100 ft. per mile, and if the river carries a heavy supercharge of silt during floods, the silt will be deposited in the reservoir and the clear water flowing out over the waste weir will scour the river. If the bed consists of boulders of 6" average diameter and over a steep slope of the order of 100 ft. per mile can eventually be made stable.

NOTE ON THE MALAKAND HYDROELECTRIC SCHEME.

The construction of the Malakand Hydroelectric scheme was commenced in December 1934, and the first stage of development is expected to be completed and put into service by December 1937. The power station is situated in Malakand Agency near Malakand. It will contain in the first stage three 3,200 kw, 11,000 volt, 3 phase water

turbine driven generating sets and is designed for extension up to six such sets. One of these sets is regarded as a stand by and the initial output will be 6,400 kw. The grid system comprises 4 substations at Mardan, Nowshera, Peshawar and Charsadda, which will be the sources of electric power for all towns and villages in the district. Power will be supplied in bulk to the Military authorities for Peshawar, Nowshera, and Risalpur Cantonments. 35 p.c. of the power will be used for bulk supply, 30 p.c. for industrial use, 20 p. c. for domestic use, 10 p. c. for irrigation and 5 p. c. for public lighting. The industrial load will be derived mostly from agricultural requirements such as flour mills, sugar mills, woollen mills, cotton ginning etc. The scope for irrigation is not very large. The rates are as follows for bulk supply. 6 pies per unit; for industrial use 6 to 8½ pies per unit; and for metered supply 4 annas per unit. Local distribution in towns and villages will be undertaken by Government.

#### SOME CHEMICAL METHODS OF WEED DESTRUCTION.

REPRINT FROM THE JOURNAL OF THE ROYAL  
AGRICULTURAL SOCIETY OF ENGLAND. VOL. 96,  
1935.

Long.  
MacDowall.

The destruction of weeds by the use of chemicals is a recent development. This pamphlet gives a brief account of weed destruction by sulphuric acid, calcium cyanamide, chlorates, and ammonium thiocyanate, and describes the machinery and other equipment required for the distribution of the chemicals. Sulphuric acid, sodium chlorate in solution, and ammonium thiocyanate in solution are sprayed on to the field by special spraying machines. Calcium cyanamide is dusted on to the field by a power blower machine specially constructed for this work. The conditions of use, limitations, effect on vegetation and crops, and other particulars regarding the use of the chemicals mentioned above are discussed in detail. The spraying and power blowing machines are described in detail with illustrations.

#### NOTES ON THE PRINCIPLES AND FORMULAE ADOPTED IN THE DESIGN OF THE "STANLEY" AND "PERIYAR" DAMS IN MADRAS.

The dams are of masonry and of the gravity type. Maximum stresses are calculated by Bouvier's method.

**THE GOVERNMENT CLERK'S COMPANION.****Keymer.**

A book on office procedure for the use of entrants in Government offices.

**STABILITY DIAGRAMS OF DAMS IN THE DECCAN IRRIGATION CIRCLE.**

Contains stability diagrams of :—

- (1) The weir at Vir, Nira L. B. Canal.
- (2) The Wilson Dam.
- (3) The Darna Dam.
- (4) The Chankapur Dam.
- (5) Nardur Madhmeswar Weir.

All the above dams and weirs are of masonry.

**NOTE ON THE RISE IN WATER-TABLE IN THE CANAL IRRIGATED AREAS OF THE PUNJAB AND ON WATERLOGGING.**

**McKenzie-Taylor**

In this note Dr. McKenzie-Taylor discusses the question of the rise of water table in canal irrigated areas of the Punjab. He differentiates between local waterlogging as in the vicinity of canals and a general rise in the water table. A study statistical methods of factors responsible for rise in the general water table led him to the conclusion that there was high correlation between rainfall and variations in the level of the subsoil water table, and the effect of irrigation on the general water table was small. Local waterlogging as in the vicinity of canals is more prevalent along canals in regions of high general water table. A further factor influencing local waterlogging is the blocking of drainages. In his opinion, rainfall assisted by blocked drainages is the controlling factor in the rise of the general water table, and he considers removal of rain water as the most important remedial measure. He does not think that canal closures are of any use as anti-waterlogging measures.

In certain cases examined, there is no correlation between rise of water table and either the rainfall or irrigation. A probable explanation is the flow of water in the subsoil in such areas from adjoining high water table areas. His conclusions are

- (a) that local waterlogging depends on the state of the general water table,
- (b) the general water table varies with rainfall in the northern parts of the Doabs, and he recommends that in the upper reaches of the Doab, measures for the

removal of rainwater should be introduced. Seepage from canals has a local effect but if the seepage is very high canals, should be lined. It would be advisable to line canals in salty reaches.

NOTE DATED 7TH AUGUST 1935 ON DR. McKENZIE-TAYLOR'S NOTE ON THE RISE IN WATER TABLE IN CANAL IRRIGATED AREAS OF THE PUNJAB.

Crump.

Mr. Crump finds it difficult to accept the views expressed in Dr. McKenzie-Taylor's note as to the relatively small effect of irrigation water on the water table. He visualizes the ground water stream as a moving mass of pitch flowing towards a capacious sink. A spray of pitch would represent rainfall and a curtain of pitch would represent the seepage from canals and rivers. He argues that in a statistical investigation of changes in the surface level of the water table, we can only express the changes as a function of the incidental and fortuitous changes in the various sources contributing to the deviations in surface level of the subsoil water table. If there is no variation in a particular source it is utterly impossible to ascertain its effect. The greater the variation in a particular source the more predominant is its effect in statistical analysis. In actual fact variations due to contribution from rainfall from year to year are much more marked than variations due to seepage from canals and field irrigation. In investigating the effects of various causes by statistical methods, the relation between the slight variation in surface level due to the small variation in seepage and field irrigation, may have been masked by the much more marked relation between large variations in surface levels due to the wide variation in rainfall. With the picture of the pitch model before us there appears to be no reason why a given volume of water added as seepage should not have the same effect as the same volume falling as rain, on the water table. He is of opinion that subsoil water table rise is roughly due  $\frac{2}{3}$ rd to rainfall and  $\frac{1}{3}$  to irrigation water.

COMMENTS ON MR. CRUMP'S NOTE ON THE NOTE BY DR. McKENZIE-TAYLOR ON THE RISE IN WATER TABLE IN CANAL IRRIGATED AREAS OF THE PUNJAB.

McKenzie-Taylor.

Dr. McKenzie-Taylor says that actual flow of water from one point to another is not necessary for a rise in water table

at the second point. All that is necessary is transmission of pressure from the first to the second point. The picture of the pitch model visualized by Mr. Crump does not conform to this aspect. He considers that the statement of Mr. Crump, that the greater the variation in a particular source the more predominant is its effect in statistical analysis is wrong. A large range of variation is not always associated with high correlation or *vice versa*. He says that irrigation is also a variable source as it is reduced in years of heavy rainfall. Rainfall is only one factor and its magnitude and high correlation place it as the predominant contribution to the rise of water table. In both rainfall and irrigation there is an immediate rise in the water table under the area in which the water falls or which is irrigated. In the case of rainfall there is a considerable lag in recovery of the water table to its original level while in the case of irrigation the recovery is rapid. This is due to the fact that in the case of rainfall the water table rises simultaneously over a large area while in the case of irrigation the rise is in a small portion of the total area. From this consideration alone rainfall would produce a more permanent effect upon the water table than irrigation.

EXTRACT FROM FORWARDING MEMO. No. G.-160,  
DATED 15TH APRIL 1936, FROM THE SUPERINTENDING  
ENGINEER, NORTHERN SIND, CIRCLE, TO THE  
CHIEF ENGINEER IN SIND REGARDING  
"MATERIAL CARRIED IN SUSPENSION IN WATER".

His impression is that material carried in suspension in water contains a very small amount of sand greater than 0.075 m. m. equivalent diameter as determined by sedimentation methods. All other material greater than 0.075 m. m. diam. moves by saltation along the bed and rises very little above it. As velocities decrease the materials of larger size settle down till a velocity of 1.25 to 1.0 ft. per sec. is reached at which the 'sandy' portions of the suspended matter settle down to some extent. Sloughing of the sides of channels he thinks is largely due to scour in the bed which results in a withdrawal of support from the toe of the slope. Many such cases have occurred on the Rohri Canal where the material of the berm is made up of particles up to 0.075 m. m. diameter. Such material is resistant to scour and does not slough in if the canal bed is stable.

DISCHARGE AND SILT OBSERVATIONS NO. 3, ABKALANI OF 1934, AND NO. 4, COLD WEATHER 1934-35, ROHRI CANAL.

DISCHARGE AND SILT OBSERVATIONS, RIVER INDUS: 10TH NOVEMBER 1934 TO 26TH FEBRUARY 1935.

DISCHARGE AND SILT OBSERVATIONS, 6 REGIME SITES ON THE JAMRAO CANAL.

REPLIES TO QUESTIONNAIRE ON MEANDERING OF RIVERS.

Claxton.

The subject of tortuosity of rivers is being investigated by the Central Board of Irrigation and a questionnaire on the subject was circulated to obtain data and information from all sources. Mr. Claxton's replies are contained herein.

NOTE ON SILT LOAD ON THE BEHAVIOUR OF RIVERS.

Claxton.

The writer gives some figures to show the enormous amount of silt load carried by rivers to the sea and states that eddying motion caused by irregularities in the bed and banks of a river is responsible for the processes of saltation and suspension whereby materials heavier than water are carried to the sea. He then attempts to show the effect of the silt load on the behaviour of the rivers. He differs from the general view that rivers assume a tortuous course to coordinate velocity to resistance of banks, and believes silt load to be the main influencing factor. His experience is that silt eroded from one bank is deposited on the same bank lower down. He refers to experiments of Gilbert and Murphy on silt transportation in California and discusses their findings as to the effect of the silt load on the stability of the river bed. He explains why a stream with diminishing silt load will scour its bed by retrogression of levels. Formation of shoals and attainment of regime conditions in a river bed are discussed.

He next deals with silt eroded from banks and carried forward by the river and forwards a theory regarding meandering of rivers. According to this theory, a river strikes a bank, erodes it, the eroded material is carried in suspension till the load is so large that it cannot be carried any further, and is deposited, as a shoal. The potential force of the moving silt load produces in reaction a strong turning force which causes a change in direction and carries the stream over to the other side. He describes a number of actual instances of river action in his own experience in support of his theories.

CORRESPONDENCE REGARDING INFORMATION ON  
"BENTONITE".

Bentonite is a material being used in America to prevent water seepage. In India this material is available in Kashmir and Jodhpur. The Senior Geologist, India, of the Burma Oil Co., Ltd., in a letter to the Secretary, Central Board of Irrigation gives a method of treatment of the Kashmir material so that it may be suitable for prevention of seepage through dams. The Jodhpur material according to him is not so amenable to treatment. The treatment consists in changing the naturally occurring material from calcium bentonite to sodium bentonite by base exchange with soda ash.

COPY OF A LETTER DATED 7TH APRIL 1937, FROM  
MR. P. EVANS, SENIOR GEOLOGIST, BURMA OIL  
CO., LTD., (INDIA) TO THE SECRETARY, CENTRAL  
BOARD OF IRRIGATION REGARDING THE "USE OF  
BENTONITE IN CANAL LINING".

In reply to a letter from the Secretary, Central Board of Irrigation enquiring whether in his opinion "bentonite" is likely to prove effective as a lining for earthen channels, Mr. Evans thinks that the suggested use of bentonite to provide a water tight lining is worth a trial. It may be possible to prepare a slurry of sodium clay, treat it with bentonite and spray the mass over the bed and banks of a canal. He suggests the inclusion in the slurry of ground sugarcane waste or some form of fibre. Another method suggested is to treat the sodium clay slurry with small quantities of magnesium oxide.

THE CHARACTER, PROPERTIES, AND POSSIBLE USES Woodman.  
OF BENTONITE, A SODIUM CLAY. Reprint from the McKenzie-Taylor.  
Journal of the Society of Chemical Industry,  
May 31, 1929, Vol. XLVIII.

Bentonite is defined as a colloidal clay occurring in large expanses in Canada and America. It swells considerably in wetting and absorbs large quantities of water. Its chemical composition is discussed, and it has been proved to consist mainly of sodium clay. A preliminary investigation of the use of bentonite as an emulsifier for such oils as kerosene, red engine oil, etc., was made some years ago. These are described and the results are tabulated. It is found to be a good emulsifier for certain oils.



THE EMULSIFYING POWERS OF BENTONITE AND Woodman.  
 ALLIED CLAYS, AND OF CLAYS DERIVED FROM McKenzie-Taylor.  
 THESE BY BASE EXCHANGE AND BY HYDROLYSIS.

Some experiments were carried out to determine the possible use of bentonite as an emulsifier. The method of experiment is described and results are presented and discussed. Similar experiments with other natural clays and derivatives of these were also carried out and results are discussed.

SUGGESTIONS DATED 3RD JUNE 1937, REGARDING  
 QUESTIONNAIRE ON CONDITIONS PREDISPOSING TO  
 HARMFUL SOIL SATURATION WHICH MAY ULTI-  
 MATELY RESULT IN WATERLOGGING.

Inglis.

Mr. Inglis suggests that replies to the Questionnaire should be arranged in 4 sections :-

- (1) General, pertaining to alluvial tracts of Northern India ;
- (2) pertaining to Deccan ; and
- (3) pertaining to Bengal.

He also suggests a new definition of waterlogging.

COMMENTS ON MR. GERALD LACEY'S NOTE ON  
 "VISCOSITY AS A FACTOR IN THE FLOW OF  
 WATER IN OPEN CHANNELS".

Bose.

Dr. Bose says that the following assumption of Mr. Lacey cannot be accepted as valid :—

"Effectively if we have a number of equations correlating hydraulic data, whatever forms these equations may take, they can only be correct when all the observations have been taken at the same temperature".

Dr. Bose says that for fluids of very small viscosity such as air or water or fluid movement with a high Reynold's number where the turbulence is very high, excepting for a small layer near the boundary, viscosity plays no part in the outside volume of the fluid and temperature will have no direct effect. Observations in the Punjab on regime canals in alluvium are stated to disprove Mr. Lacey's assumption and bear out Dr. Bose's contention.

NOTE ON TRAPEZOIDAL FLUME OUTLETS.

Brown.

In connection with the design of an outlet that would discharge proportionately to the parent channel discharge throughout the range of fluctuation of discharge for which the kharif channels of the Sutlej Valley Project have been designed, a convergent trapezoidal flume outlet was

designed. The author on working out the theory of trapezoidal outlets found that a divergent trapezoidal flume outlet was more suited for the purpose and his theoretical discussion is appended. It was thereupon decided to build a convergent and a divergent outlet for identical conditions, and to test them. The designs of the outlets and the experimental observations on them are given and also their discharge curves. The experiments confirmed the theory that a divergent outlet could be designed for a smaller variation in flexibility than a convergent one but neither outlet appeared to be a practical proposition owing to the difficulty of constructing them.

The differences between the theoretical and actual discharges through the outlets as observed are attributed to friction, and the effect of friction on the discharges is discussed theoretically. A second divergent outlet was designed to test the friction theories and experimental results are presented. The author is doubtful whether these outlets would ever be a practical proposition. He suggests experimenting with another type of outlet in which the lower part of the divergent section is made in the form of a rectangle of equal area to the trapezoid. He discusses the theory of this form of outlet and says that if further experiments are contemplated, they should be directed to this new form of outlet.

NOTE ON THE DESIGN OF A. P. M. CUM FLUME  
PROPORTIONAL OUTLETS.

Brown.

In connexion with the design of outlets required to discharge proportionally to the parent channel discharge throughout a wide range of variation in the parent supply, the author indicates the possibilities of a combination of an A. P. M. outlet and a broad crested flume outlet. An alternative combination of two A. P. M. outlets is also considered. It is shown how these combinations should be designed to secure the best results. The theory forming the basis of design is discussed and rules for design are summarized. A few examples of design are also given. These combinations have not so far been tested experimentally.

COPY OF A LETTER DATED 10TH APRIL 1937, FROM  
CHIEF ENGINEER, BENGAL TO THE SECRETARY,  
CENTRAL BOARD OF IRRIGATION REGARDING  
"GENERATION OF ELECTRIC POWER FROM CANAL  
FALLS AND WATER REQUIREMENTS FOR PRINCIPAL  
IRRIGATED CROP IN BENGAL".

In his opening speech at the Seventh Annual meeting of the  
Central Board of Irrigation His Excellency the Viceroy

suggested the consideration of the possibility of hydro-electric development in future irrigation schemes. The minutes of the Proceedings of the meeting were forwarded to Members of the Board and this letter is in connection therewith.

The Chief Engineer writes that no perennial canal is in operation yet in Bengal and the use of canal falls for generating electric power is impracticable. Arrangements will be made in the storage dams for the Mor and Darakeswar Canals for generation of power and the falls on those canals can also be utilized for the same purpose.

Requirements of water for paddy as determined in Bengal are given for the period June to November. The total requirement is 40 inches of which 20 inches are required in June and July. The amount of 40 inches total depth is held to be the minimum necessity in Bengal.

COPY OF A LETTER DATED 2ND APRIL 1937, FROM  
CHIEF ENGINEER, BURMA TO THE SECRETARY,  
CENTRAL BOARD OF IRRIGATION REGARDING  
"HYDRO-ELECTRIC DEVELOPMENT IN BURMA".

The Chief Engineer says that the irrigation systems in Burma do not lend themselves to hydro-electric development. All systems except one operate during the rains. Water table is very low and irrigation by pumping is impracticable. The rivers with one exception have a very small discharge from December to May.

COMMENTS ON MR. GERALD LACEY'S NOTE ON "VIS-  
COSITY AS A FACTOR IN THE FLOW OF WATER IN  
OPEN CHANNELS".

**Malhotra.**

Mr. Malhotra says that Mr. Lacey's formulae were deduced by a process of graphical analysis of hydraulic data. An exact discussion of the flow of water in our present state of knowledge is neither possible nor available and so it must be conceded that finality in the subject is still far from being attained. The formulae are therefore subject to the usual limitations of others of the same class obtained by statistical analysis. With regard to the assumptions that factors containing kinematic viscosity and gravity can be obtained by dimensional analysis, he says that dimensional analysis is not valid unless it is shown that no other variables exist. Dimensional analysis can only serve as a verification and not as a proof of the correctness of the formulae which must be obtained by other methods. He further says that gravity ( $g$ ) is a constant throughout the world and should not figure at all in a dimensional

analysis. The formulae in their new form therefore cannot be taken to be proved even if the results obtained are dimensionally correct.

He welcomes Mr. Lacey's assumption that his silt factors have the dimensions of an acceleration because it gives a physical meaning to the silt factor. There is some confusion as to the relations of the various silt factors and he has given an analytical discussion in which he arrives at some relationships which are the converse of what Mr. Lacey has deduced. The point he says needs elucidation.

#### SKETCHES OF THE LIVES OF FOUR EMINENT ENGINEERS.

Contains brief life sketches of Lt.-General J. G. Fife (who retired as Chief Engineer of Irrigation Department, Bombay in 1876), Mr. Arthur Hill, C.I.E. (who was Chief Engineer, Bombay, about 1910), Mr. H. F. Beale (who was Chief Engineer, Bombay, about 1916) and Sir C. S. C. Harrison, Kt., C.I.E. (who was Chief Engineer in Sind, about 1932).

REMARKS BY D. V. JOGLEKAR ON A PAPER ENTITLED  
"THE HYDRAULIC JUMP OVER OGEE SPILLWAY  
DAMS: DEVELOPMENT OF FRICTION FACTOR 'n'  
IN MANNING'S FORMULA FROM OBSERVED DATA  
ON A HIGH CRESTED OGEE DAM" BY J. L. SOUTHWORTH.

Joglekar.

He says that in general this method (given by Mr. J. L. Southworth) of finding the depth of water from values of  $n$  does not appear to be sound.

#### IRRIGATION FLOW DIVISORS.

This is a pamphlet issued by Messrs. Neyret-Beylier and Piccard-Pictet (N. B. F. P.), France. It describes, with illustrations, their patents for special devices applicable to irrigation division flow problems, *e.g.*, Weir with conical sill and rotating splitter; Weir with special check, forming an automatic locking or module with quasi-constant flow; Proportional divisor for steep flumes; Automatic gate with constant upstream level; Gate with a constant downstream level; and Butterfly valve with a constant flow. The application of these devices, in respect to both proportional and take-off division, is also described.

#### AUTOMATIC CONTROL OF RIVERS AND CANALS.

This is a pamphlet issued by Messrs. Barrages Automatiques, Ltd., and describes by illustrations their twelve types of automatic gates as well as the works where they have been applied.

**WATER WORKS FITTINGS.**

This is a catalogue of the appliances made by Messrs. Glenfield & Kennedy, Ltd.

**WEEDS. (Rural Science Series).**

Muenschner.

This book deals quite comprehensively with weeds as affecting growth and yield of agricultural crops and also the strength of soils. It is divided into two parts. Part I is devoted to a consideration of those characteristics and habits of weeds by which they affect other plants or interfere with man's activities, and also to the methods employed for their eradication and control. In Part II is brought together data concerning the names, duration, reproduction, dissemination, habitat, range, source, recognition, and control of the commonest weeds of the Northern United States and Canada. Particular emphasis has been given to identification and control.

**CONTRIBUTION TO THE STUDY OF THE WATERS AND SILT OF THE NILE (In French).**

Mosseri.

This is a posthumous work of Victor M. Mosseri. It contains results of chemical analyses of Nile water, and chemical and mechanical analyses of Nile silt.

**MAPS, BLUE PRINTS AND PHOTOGRAPHS.***United Provinces.***Salawa Power Station :**

Photograph showing automatic gate on main canal fall at Salawa. 20th April 1936.

Photograph of Salawa Power Station, downstream view. 20th April 1936.

Plan of Concrete work in connection with the installation of two automatic gates  $4\frac{1}{4}' \times 40'$ .

Drawing of four automatic gates (pivoted weirs) at Salawa and Chitaura Power Stations. Width  $25'-1''$ , and height  $5\frac{1}{2}'$ .

Plan of Concrete Work (Reinforcing rods) in connection with installation of two automatic gates  $4\frac{1}{4}' \times 40'$ .

Plan of Concrete Work in connection with installation of two automatic gates of height  $5\frac{1}{2}'$  and length  $25'-1''$ .

**Chitaura Power Station :**

Plan of Concrete Work (Reinforcing rods) in connection with installation of two automatic gates of height  $4\frac{1}{4}'$  and length  $40'$ .

For the drawing of automatic gates at Chitaura Station see also under "Salawa Power Station".

*Punjab.*

## Thal Project :

Kala Bagh Weir Plan : Counterbalanced tilting radial gates.  
(Proposal II). 3rd July 1936.

For a proposed design of an automatic falling shutter for a weir,  
see under "General".

*Bombay.*

## Madleri Tank :

Cross Section. 17th November 1933.

*Sind.*

Drawing showing arrangement for lowering electric current  
meter.

Drawings showing details of lowering electric current meter.

*Baluchistan.*

Typical cross section of the Spin Karez Dam, Baluchistan.

*N.-W. F. P.*

For plans of river behaviour of the Indus see under "General".

*Indian States.**Gwalior.*

Photograph of Harsi Dam.

Photograph of Kaketo Dam.

*Burma.*

Myaungyan-Minhla Tank, Meiktila Irrigation Division :

Section of Bund No. 11, at breached portion in 1935.

Section of Bund No. 12, at breached portion in 1935.

Section of Bund No. 13, at breached portion in 1935.

Section of Bund No. 14, at breached portion in 1935.

*General.*

Plan of Type or Generalization of Aluvial River.

Section of Type Alluvial River.

Plan showing River Behaviour of Indus near Kala.

Survey Plan of River Behaviour of Indus opposite Dera Ghazi-  
khan showing position of the river in 1927-28, 1930-31,  
1931-32, 1932-33, 1933-34 and 1934-35.

Plan showing River Erosion and Shoaling of river Indus at Lundi  
1931-32.

Plan showing proposed design (Designed by Mr. Wheatley,  
Superintendent, P. W. D. Central Workshops, Amritsar)  
of an automatic falling shutter for a weir.

## NEWSPAPER CUTTINGS.

IRRIGATION IN MYSORE : CONSTRUCTION OF NEW  
RESERVOIR. March 30, 1937.

Review of the Mysore Public Works Department's work for the year 1935-36. The construction of the Anjanapur Reservoir, of anicuts across the Bhruagu, near Halsur, and across the Maralwadi and Vrishachavati rivers are among the major works. The new tank at Nidsala was also completed. Fourteen out of the 55 major tanks were restored and 53 minor tanks out of 179 were repaired.

The recommendations of the special committee which considered the several aspects of irrigation and power development under the Lakkavalli reservoir scheme are under the consideration of the Government.

TUBE-WELL SCHEME FOR RAMPUR STATE : SIR  
WILLIAM STAMPE'S SPEECH AT OPENING : IN-  
CREASED SOCIAL AMENITIES FOR PEASANTS.  
April 5, 1937.

The speech was delivered at the opening ceremony of the first instalment of 10 tube-wells out of a scheme of 34. This project was initiated in 1935 as a substitute for the proposed canal from the Gangan river. It is contended that "not only has the capital outlay on the wells been considerably less than that of a river canal but the annual expenses are lower". Electricity for pumping water has been taken from the Salawa Power Station in the United Provinces where it is being generated from the Ganges water falling 15 feet.

DEVELOPMENT OF ELECTRIFICATION IN THE U. P.  
April 5, 1937.

A U. P. Government press communiqué outlining the policy of the Local Government in respect of the measures to be adopted for the systematic development of electrification, both urban and rural, in the eastern districts of the United Provinces, was explained in a press communiqué published on January 1, 1937. The present communiqué outlines the steps which have since been taken to implement that policy.

A steam generating station and the pumping plant are being constructed near Fyzabad and it is hoped that these works will be in operation in August 1937 and will irrigate an area of 44,000 acres, and secure cheap power for local tube-wells and village industries.

The so-called "Eastern Grid Project" which is being examined by Messrs. Sir Alexander Gibb and Partners, Consulting Engineers, Westminster, comprises the construction of a hydro-electric power station on the Garai river in the Mirzapur district together with the necessary aqueducts and pipelines and an impounding reservoir on a tributary of the Karamnasa river. It is considered that some 8,000 K. W.'s can be made available from this station.

The feasibility of generating a similar quantity of power on the Tons river in the Rewa hills is also under discussion with that State.

For irrigating the Fyzabad and Benares districts a reconnaissance is now being conducted to ascertain the geological suitability of the sub-soil for a system of tube-well irrigation. Besides serving for the extension of irrigation, the eastern grid scheme will be used for development of minor industries in the towns and larger villages traversed by the system.

#### ELECTRICITY FOR U. P. VILLAGES : OFFICIAL SCHEME BEING DISCUSSED. April 19, 1937.

Sir William Stampe discussed the scheme of village electrification, which is likely to employ about 200,000 persons, with M.L.As. and other prominent people.

#### IRWIN CANAL AREA IN MYSORE : DEVELOPMENT PLANS. April 19, 1937.

The Standing Committee for the working of the Krishnaraja Sagra Irrigation Works met in camera and it is understood that control of malaria in the area, provision of inter-village roads, a scheme for settling educated unemployed in the area, etc., were discussed. The committee decided to extend the distribution channels to serve the drier regions of Madur, Mandya and Nagamangala in preference to the scheme to extend the Shimsa branch of the canal to the tail lands in Narsipur Taluka.

#### CONSTRUCTIVE THOUGHT IN RELATION TO DEVELOPMENT : SIR WILLIAM STAMPE ON POSSIBILITIES OF ELECTRICITY SCHEME : ADDRESS TO STUDENTS OF BENARES UNIVERSITY.

The address gives a bird's-eye-view of the system of electrification undertaken by the U. P. Government in the various parts of the Province and mentions the existing works as well as the lines on which further development is possible.



**REDUCTION OF CANAL RATES: April 28, 1937.**

This is a letter to the editor by Rai Bahadur L. Anand Sarup, Honorary Secretary, U. P. Zamindar's Association, Muzaffarnagar, U. P. He urges the reduction of canal rates in the U. P. after comparing them with the rates in other Provinces as well as those which were in force in the U. P. in the pre-war period.

**BOMBAY IRRIGATION PROBLEMS: ENQUIRY COMMITTEE TO BE APPOINTED. April 29, 1937.**

The Bombay Ministry has decided to appoint a committee to investigate (1) the feasible expansion of irrigation in the different districts and as to how far the various minor irrigation schemes worked out by the Special Officer, Mr. Lawsley, could be introduced, particularly in the scarcity areas; (2) whether water rates can be reduced; (3) what steps should be taken in case of lands and villages damaged by waterlogging; and (4) the feasibility of permitting the use of tail waters from hydro-electric schemes for agricultural purposes.

**ASSESSMENT OF CANAL DUES: NEW RULES FOR DELHI. April 30, 1937.**

The Chief Commissioner of Delhi notifies certain amendments to the Northern Indian Canal and Drainage Act of 1873, as amended by Devolution Act, 1920, in connection with the assessment of owner's rates in the Delhi Province.

**BOMBAY MINISTRY: PROGRAMME ABOUT IRRIGATION. May 2, 1937.**

The Ministry has announced that a committee will be appointed to investigate certain matters (given in the cutting dated April 29, 1937).

**RS. 5,00,000 SCHEME: DEG DIVERSION WORKS IN PUNJAB COMPLETED. May 2, 1937.**

The object of the scheme was the diversion of the Chenab supply for the Lower Bari Doab Canal from its present course of 37 miles below Chichoki Malian, to another course which is only about 18 miles long, with a view to remove waterlogging in this part of the Sheikhpura District. The works consist of a fall at the head of the diversion channel, a linking scheme in the interests of all distributaries on the right and left of the Upper Chenab Canal and the development of 4 miles of channel to enable the maximum discharge of 6,500 cusecs. required for the Lower Bari Doab Canal, to be carried into the Ravi river.

**HARNESSING THE SHIMSA : SIR MIRZA ISMAIL'S  
KEEN INTEREST. May 4, 1937.**

With the increased demand for electricity owing to increase in industries as well as the Durbar's policy of rural electrification, the Government of Mysore are now considering the possibility of harnessing the Shimsa river a few miles from Sivasamudram. There is a fall of more than 500 feet from the Shimsa and with a dam erected it will be possible to harness it. The scheme is expected to cost more than a crore of rupees.

**CURRENT TOPICS : POWER GENERATION, May 4,  
1937.**

It is claimed that the proposed harnessing of the Shimsa Falls in the Mysore State will generate as much as 25,000 horse power.

**FLOOD SITUATION IN NORTH BIHAR : PREMIER'S  
LETTER TO BABU RAJENDRA PRASAD : APPEAL  
FOR SUPPORT AND CO-OPERATION. May 5,  
1937.**

The letter is in reply to Babu Rajendra Prasad's letter which brought to the notice of the Government the seriousness of the flood problem in Bihar. Babu Rajendra Prasad in his letter points out that at the back of the North Bihar flood problem lies the very big question whether in an alluvial country it is better to sweep away all embankments and allow flood water to spread over the whole country or whether it is better to confine it to recognized channels by means of embankments. The premier proposes methods of encouraging self-help among local people by repairing private embankments.

**FLOOD PROBLEM IN NORTH BIHAR : BABU  
RAJENDRA PRASAD'S REPLY TO CHIEF  
MINISTER : SUGGESTIONS FOR REMEDIAL  
MEASURES. May 7, 1937.**

Babu Rajendra Prasad replies that the problem of flood control in Bihar is very big and mere self-help by local people would not solve the problem. He suggests the appointment of an expert committee with sufficient experience of large floods and river training. He gives the effect of the last earthquake in reducing the river capacity to drain away the flood and rain water, and says that devastation by floods can be prevented if the flood waters are utilized for agricultural and other purposes.

**ELECTRICITY FOR IRRIGATION : UTILIZING TUBE-  
WELLS. May 13, 1937.**

New schemes, at present under the consideration of the Punjab Government, include possibilities for an extended use of electrically operated tube-wells for irrigation purposes. One difficulty in the Punjab is that the sub-soil water is saltish in many districts.

**CENTRAL BOARD OF IRRIGATION : COMING  
MEETING AT SIMLA. May 13, 1937.**

Refers to the meeting of the Research Committee of the Board in June.

**QUETTA SCHEME TO END DROUGHT : KAREZ  
VALLEY DAM. May 15, 1937.**

The present water supply of Quetta depends on the spring at Urak which is at no time more than enough to last for three days. There is thus a proposal to construct an earthen dam 2,375 feet in length with a maximum height of 83 feet in the Karez Valley about 7 miles from Quetta Cantonment. This dam will impound 162,000,000 cubic feet of flood water which although not sufficient in itself to supply the whole of Quetta's needs will supplement the Urak supply in years of drought. The work is expected to take three years to complete and will cost Rs. 8½ lakhs which will be met by the Government of India. (This appeared on page 13 of Quarterly Bulletin No. 3.).

**DISTRIBUTION OF WATERS OF INDUS AND TRI-  
BUTARIES : LONG-STANDING DISPUTE ENDED :  
INDIAN GOVERNMENT ACCEPT INQUIRY COM-  
MITTEE'S PROPOSALS. May 15, 1937.**

The Committee was a Sub-Committee of the Central Board of Irrigation convened by the Government of India. Mr. F. Anderson, C.I.E., was the Chairman of the Committee.

**USE OF TIMBER FOR BRIDGES : FOREST RE-  
SEARCH : NEW TYPE OF MATERIAL AND DESIGN.  
May 16, 1937.**

Review of a pamphlet "Treated Timber Bridges for Indian Highways and Railways" issued by the Forest Research Institute at Dehra Dun.

**ADEQUATE WATER FOR QUETTA : 8½ LAKE SCH-  
EME. May 16, 1937.**

Same as in the cutting of May 15.

**NEW ORIENTATION OF IRRIGATION POLICY :  
CENTRAL GOVERNMENT'S CIRCULAR. May 17,  
1937.**

The Circular referred to is not of the Central Government but of the Central Board of Irrigation. The Circular was

issued to all Provincial Governments in pursuance of the Board's Resolution at the 7th Annual Meeting in 1936, with a view to eliciting information about the extent of benefits directly or indirectly accruing to the Provincial and Central Governments so that if the benefits accruing to the Central Government be appreciable, that Government should see its way to contribute towards the cost of future irrigation projects, and Provincial Governments should view them from a different aspect.

**CENTRAL BOARD OF IRRIGATION : RESEARCH COMMITTEE MEETING IN JUNE : REPRESENTATIVES OF PROVINCES TO ATTEND.** May 18, 1937.

**IRRIGATION IN INDIA : RESEARCH COMMITTEE TO MEET.** May 18, 1937.

These two cuttings refer to the meeting of the Research Committee of the Central Board of Irrigation in June.

**CHIEF MINISTER TOURS IRRIGATED TRACTS IN AHMEDNAGAR : CORDIAL WELCOME BY VILLAGERS : POONA LEADERS APPLAUD BOMBAY CABINET'S PROGRAMME.** May 18, 1937.

**IMPROVEMENT OF SEHERWAH CANALS SYSTEM.** May 18, 1937.

A scheme for the improvement of the Seherwah Canals System of the Shikarpur Division estimated to cost Rs. 1,50,000 is being worked out. The scheme includes the construction of three regulators, a new distributary, and the widening or re-sectioning of the entire canal. The scheme is considered necessary, as owing to the shortage of water in the river, there is a deficiency of water on this system of canals.

**TAXATION ON WELL WATER : A BILL TO AMEND LAND REVENUE ACT.** May 20, 1937.

A bill to amend the Hyderabad State Land Revenue Act is to be moved in the State Council. The effect of the amending bill will be to make the ryots not only sink new wells but also keep old wells in good condition, thus saving the Government from sustaining any loss.

**IRRIGATION RESEARCH AT POONA : PREVENTING EROSION BY RIVERS.** May 21, 1937.

Gives briefly the results of model experiments conducted at the Poona Research Station on erosion by the river Padma and its probable effect on the Hardinge Bridge at Sara. These experiments were undertaken at the instance of the Railway Board.

**WEIRS ON SANDY FOUNDATIONS : SAFE DESIGN  
EVOLVED BY INDIAN ENGINEER. May 22, 1937.**

Says that the problem of weirs on sandy foundations, which has long been baffling irrigation engineers, has been solved and the credit goes to a band of research workers in the Punjab, particularly Rai Bahadur A. N. Khosla, Executive Engineer. Rai Bahadur A. N. Khosla conducted experiments in the field while Dr. McKenzie-Taylor and Dr. N. K. Bose tested them in the laboratory. It is stated that "India is the first to give this design to the world of which full details will shortly be published by the Central Board of Irrigation".

**REVENUE SYSTEM IN BENGAL : IMPORTANT  
CHANGES TO BE MADE. May 22, 1937**

It is understood that the Government propose to introduce at the next session of the Bengal Assembly a bill to meet some of the popular demands of the ryots and that the Government is contemplating to appoint a commission to enquire into the whole land revenue system of the province.

**BETTERING LOTS OF AGRICULTURISTS : SRIMOOR  
STATE'S MEASURES. May 22, 1937.**

A measure known as the Peasants' Protection Act will be enacted shortly. The Act aims at affording cheap credit facilities and supplying good quality grain and seed at cheap rates. It also provides against attachment by civil courts of rural stocks and holdings of agriculturists.

Another measure under contemplation is the Land Tenancy Act on the lines of the British enactment.

**EROSION OF PADMA : EFFECT ON HARDINGE  
BRIDGE. May 22, 1937.**

Same as in the cutting of May 21, 1937.

**TUBE-WELL IRRIGATION IN U. P. : SCHEME  
SANCTIONED. May 22, 1937.**

The Scheme referred to is the U. P. State Tube-well Irrigation Scheme comprising the construction of some 1,500 tube-wells in the western districts of the Province. The scheme has been developed from a series of projects sanctioned as separate estimates under the powers of the local Government but the sanction of the Secretary of State became necessary when it was decided to combine these various projects under one consolidated estimate.

**TUBE-WELL IRRIGATION IN THE U. P. : WHAT THE GRID SCHEME HAS ACHIEVED.** May 23, 1937.

**LAND FOR FODDER CROPS : PROPOSAL TO BE DISCUSSED AT CATTLE CONFERENCE.** May 24, 1937.

One interesting proposal will be that certain perennial grasses which can be grown where water is available, should be planted on the sides of nullahs where there is leakage from canals or wells.

**LACK OF OPPORTUNITY.** May 25, 1937.

Referring to the ingenuity of Rai Bahadur A. N. Khosla, who has evolved a safe design for weirs on sandy foundations, says that if opportunities are given Indian talent will be able to prove its worth in every field of human enterprise.

**MYSORE ELECTRIC SUPPLY : PLAN TO COPE WITH INCREASED DEMAND.** May 27, 1937.

Two schemes for the development of electric supply are under consideration of the State Government. The Shimsa Valley scheme, calculated to produce 15,350 h.p. is expected to cost Rs. 62,00,000. The Gersoppa falls scheme will cost Rs. 1,50,00,000 but is expected to produce only 10,000 h.p.

**OUR BIHAR LETTER : FLOODS DUE TO RAILWAY EMBANKMENTS.** May 28, 1937.

The letter contains remarks on three Government communiqués dealing with the report of the committees appointed by the Government to report on the problem of floods in North Bihar. One of the conclusions that the committees have reached is that railway embankments are also responsible for aggravating the rigours of floods, but the letter says that the astounding fact is that representatives of the B. & N. Railway have dissented from this.

**IRRIGATION RESEARCHES : PROBLEM OF HAVING A CENTRAL STATION.** May 28, 1937.

Remarks on the fate of the Hydro-dynamic Research Station at Poona, which is being run by the Government of India for the year 1937-38

**KARWAR-MADRAS FRONTIER ROAD : CAUSEWAY TO BE BUILT ACROSS BADGANI CREEK,** May 28, 1937.

See page 13 of Bulletin No. 4.

**IRRIGATION FACILITIES FOR RYOTS : AGRARIAN  
PROBLEM IN BIHAR CONGRESS KISAN INQUIRY  
RECOMMENDATIONS. May, 30, 1937.**

It is understood the committee will suggest reduction of existing canal rates and imposition of irrigation cess on zemindars where the canal system does not exist.

**ELECTRIC POWER FOR MYSORE : SCHEMES FOR  
INCREASING CAPACITY. June 1, 1937.**

Detailed information about schemes mentioned in the cutting of May 25, 1937.

**IRRIGATION RESEARCH IN PROVINCES : CENTRAL  
BOARD'S REPORT FOR 1936-37 : CHEMICAL  
ANALYSIS OF PUNJAB SILTS. June 1, 1937.**

Refers to the Report of the Technical Work done by the Central Board of Irrigation during 1935-36 (not 1936-37). The Annual Report contains minutes of the Research Committee and Annual Board meetings held during the year together with other activities of the Board. (The subjects discussed and conclusions reached at the meetings have already appeared in these Quarterly Bulletins.)

**MALARIA AND IRRIGATION PROJECTS : AN AGENCY  
NEEDED TO CO-ORDINATE PUBLIC WORKS :  
ENGINEERS AND TRAINING AND SANITATION.  
June 1, 1937.**

Points out the necessity of a co-ordinating agency for forestry, irrigation, agriculture, hydro-electric and public health departments as they are all inter-related subjects. Also says that before any irrigation or railway project is sanctioned it should be examined by experts in public health, irrigation, agriculture and hydro-electricity.

**SURFACE SOIL IN SIND : SATISFACTORY RESULTS  
OF INVESTIGATIONS. June 3, 1937.**

It is said that recent investigations carried on by the Development and Research Division on surface and sub-surface soil have given very satisfactory results which will be useful to other provinces and also to the Agricultural Department.

**PUNJAB PERENNIAL IRRIGATION SCHEME : BAR-  
RAGE AND CANALS TO BE CONSTRUCTED : PRO-  
JECT TO SUPPLY WATER TO HUGE TRACTS OF  
LAND. June 4, 1937.**

Refers to the Haveli Project, preliminary work on which has just started. The scheme comprises five units, namely,

Trimmu Headworks on Chenab, Abdul Hakim headworks on Ravi, left bank canals, right bank canals, and Montgomery-Pakpatan link. The scheme is estimated to cost over 5 crores of rupees and is designed to provide perennial irrigation to a gross area of about 700,000 acres besides non-perennial irrigation of about 86,000 acres.

BUTLERGANJ BUND ON THE GOMTI : LUCKNOW  
BOARD ASKED TO REPAIR : GOVERNMENT  
THREAT TO SUPERSEDE : June 4, 1937.

The Bund was the property of the provincial Government but the Government ordered the Municipality to repair it as it was contended that the bund was damaged by floods owing to the existence of a weak sewer.

HYDRO-ELECTRICITY IN MYSORE : FUTURE PLANS  
EXAMINED. June 4, 1937.

IRRIGATION IN THE PUNJAB : UTILIZING INDUS  
WATERS : PROJECTS OF CRORES OF RUPEES.  
June 4, 1937.

Gives some features of the Haveli Project, preliminary work on which has just started.

Also says that it is understood that the Thal project has passed the scrutiny of the irrigation experts and that the Government may seek the approval of the Assembly during the next session.

IRRIGATION AND INDIAN ECONOMY : STATISTICS  
FOR 1934-35. June 5, 1937.

Review of the 1934-35 Statistics issued by the Government of India.

PROGRESS OF CANAL IRRIGATION IN BIHAR :  
ADMINISTRATION REPORT FOR 1935-36. June  
6, 1937.

Review of Administration Report of the Irrigation Department, Bihar and Orissa for 1935-36.

CURRENT TOPICS : FLOOD PREVENTION. June 6,  
1937.

Refers to President Roosevelt's message recommending the establishment of seven regional authorities for the prevention of floods, drought and storms.

CURRENT TOPICS : FLOURISHING THE SWORD.  
June 6, 1937.

Criticises the Government's action in threatening the Lucknow Municipality to repair the damaged bund over the river Gomti. (See cutting of June 4, 1937.)



**IRRIGATION SCHEME : Rs. 75,00,000 FOR KHAIR-  
PUR STATE PROJECT. June 7, 1937.**

The project is designed to remodel the irrigation system in the State and bring it into line with that of Sind. (It is said that the project has been sent up to the Central Board of Irrigation for scrutiny but this is not so.)

**IRRIGATED AREAS IN INDIA : 84 PER CENT. UNDER  
FOOD CROPS. June 7, 1937.**

Same as cutting dated 5th June.

**IRRIGATION BOARD'S AGENDA : SIMLA MEETING.  
June 9, 1937.**

Gives briefly the agenda of the meeting of the Research Committee of the Central Board of Irrigation in June.

**MARALA WEIR HEADWORKS : Rs. 15½ LAKE  
SCHEME FOR REMODELLING. June 11, 1937.**

See page 13 of Quarterly Bulletin No. 4.

**MYSORE SURPLUS BUDGET : BIG INCREASE IN  
ELECTRIC POWER CONSUMPTION : DEWAN'S  
ADDRESS TO ASSEMBLY. June 15, 1937.**

Refers to the increased consumption of electric power in the State and to the proposed building of a power station at Shimsa Falls.

**WATERS OF THE INDUS. June 16, 1937.**

Certain remarks on the recommendations of the Sub-Committee of the Central Board of Irrigation on "Distribution of the Waters of the Indus and its Tributaries" appointed by the Government of India, under the chairmanship of Mr. F. Anderson, C.I.E., Chief Engineer, U. P.

**OUR CALCUTTA LETTER : AGITATION OVER DAMOODAR  
CANAL : PLEA FOR IMPARTIAL ENQUIRY. June 16, 1937.**

Criticises and points out the dangers resulting from the embankment on the northern bank of the Damodar river in the Burdwan district. Gives the history of the embankment and suggests the ways in which it can be made to benefit the people. It is claimed by the people that there should be embankments on both the northern and southern banks as prior to the construction of the line of the E. I. Railway in 1850, but there should be a sufficient number of sluices in both the embankments as also in the railway line in order to allow flood water to pass unhampered. It is also said that even the construction of the Damodar canal has not been able to protect the people from floods. In connection with the canal it is pointed out that the heavy

tax imposed on the people under the Rural Development Act will make the canal disadvantageous to the people instead of advantageous.

**GEODETIC OPERATIONS IN 1936 : SURVEY OF  
INDIA'S ACTIVITIES : PARTY'S ADVENTURES ON  
ASSAM-BURMA FRONTIER. June 16, 1937.**

Review of the Report of Geodetic Operations in the year 1936.

The report, among other subjects, deals with the study of subsoil water levels. In this connection a very detailed survey has been made covering an area of about 3,000 sq. miles, and the end of a long ridge (Shahpur-Delhi ridge) buried below the silt, which extends to near Delhi, has been charted. The effects of this ridge on the water levels in the Indo-Gangetic Plain have been shown.

**DISPUTE OVER SHARING OF TUNGABHADRA WATER :  
MADRAS GOVERNMENT TO AGREE TO A DRAW-OFF  
ON HYDERABAD SIDE : ARBITRATION PROPOSED.  
June 17, 1937.**

As the Madras and Mysore Governments have come to an agreement, the former have written to the Hyderabad Government that they are disposed to agree to a draw-off by diversion of the canal on the Hyderabad side equivalent to that by the Kurnool-Cuddapah canal on the British side. But the Hyderabad State wishes to examine whether the Mysore Government have radically changed their claims. Hyderabad thinks it better to entrust the whole case to the Government of India instead of an arbitrator.

**DRAINAGE IN SIND. June 17, 1937.**

Refers to the investigations made into the question of movement of sub-soil water in Sind, particularly in the barrage area.

**BAGHAR INUNDATION CANAL : COMBINED REGU-  
LATOR AND ESCAPE UNDER CONSTRUCTION.  
June 17, 1937.**

See page 6 of Quarterly Bulletin No. 5.

**DRAINAGE OF LAND IN GANGES BASIN : EFFECT  
OF 1934 BIHAR EARTHQUAKE : GENERAL SUR-  
VEY CONDUCTED BY EXPERT. June 17, 1937.**

The results of the report of the engineer appointed to survey areas in north Bihar to see the effect of the last earthquake on the drainage problem in that area, are being examined by the Government and gradually given effect to.

**CENTRAL BOARD OF IRRIGATION : ANNUAL MEETING OF RESEARCH COMMITTEE. June 17, 1937.**

Gives briefly the agenda of the meeting of the Research Committee in June.

**ELECTRIFICATION AT MYSORE : PART COMPLETED. June 17, 1937.**

The Pykara plant which has been connected with the Mettur station has been put into operation. (This plant is in the Madras Presidency and not in Mysore State.)

**IRRIGATION IN SUKKUR : SIND GOVERNMENT'S SCHEME. June 17, 1937.**

Estimates are stated to have been prepared for constructing some tube-wells for irrigation costing about Rs. 10,000 each. A tube-well will give a discharge of a cusec and a half, sufficient to deal with about a square mile of ground at a cost of approximately Rs. 12 per acre. Borings will shortly be made to test the water.

**IRRIGATION RESEARCH IN INDIA : ENGINEERS TO MEET NEXT WEEK. JUNE 17, 1937.**

Refers to the Research Committee meeting of the Central Board of Irrigation and gives agenda.

**CANAL IRRIGATION RESEARCH : SIMLA DISCUSSIONS. June 17, 1937.**

Same as above.

**VICEROY'S EXECUTIVE COUNCIL : RESHUFFLING OF DEPARTMENT. June 18, 1937.**

Refers to the proposal to change the present two Departments of Commerce, and Industries and Labour, in the Government of India to three Departments of Commerce, Communications and Labour. Irrigation will come under Labour.

**POPULATION AND FOOD PLANNING : OCCUPATIONAL MAL-ADJUSTMENT : INDIAN PROFESSOR'S LECTURE IN LONDON. June 19, 1937.**

Lecture of Prof. Radhakamal Mukerjee before the London School of Economics.

**CENTRAL BOARD OF IRRIGATION : ANNUAL MEETING OF RESEARCH COMMITTEE. June 19, 1937.**

Gives the agenda and the names of the officers attending.

**IRRIGATION AND THE SPREAD OF MALARIA :  
HEALTH OFFICERS' VIEWS : JUNE 19, 1937.**

Refers to the pamphlet "Man-made Malaria in India" issued by the Public Health Commissioner, in which it is stated that prevalence of malaria is attributable to engineering works, particularly irrigation works. Also refers to Mr. T. B. Tate's note on the policy of irrigation in India published in the Annual Report for 1935-36 of the Central Board of Irrigation and says that although it was expected that the Board would suggest that engineers should get training in tropical hygiene, it has given a different reason for this malady, namely, the lack of sufficient provision in the estimates for irrigation projects to cover the cost of drainage along the canals.

**MADRAS-TRAVANCORE ARBITRATION : NORTH  
INDIAN JUDGE TO BE UMPIRE. June 20, 1937.**

It is now known that the arbitration on behalf of the Governments of Madras and Travancore in the dispute between the two Governments as to the right of the former to generate electric power from waters impounded by the Periyar Lake besides utilizing them as at present for irrigation, have chosen a North Indian High Court Judge as umpire to adjudicate the issues arising out of their different awards.

**IRRIGATION IN BIHAR : POSSIBILITIES OF NEW  
SYSTEM. June 21, 1937.**

The possibilities of mechanically operated tube-wells for purposes of irrigation on a wide scale in Bihar are being investigated by the local Government.

**TUNGABHADRA PROJECT : IRRIGATION ENGINEERS  
TO CONFER. June 22, 1937.**

To discuss the scheme the Chief Engineer, Hyderabad State will meet the Chief Engineer for Irrigation, Madras.

**CENTRAL BOARD OF IRRIGATION : SEVENTH  
ANNUAL MEETING OF RESEARCH COMMITTEE :**

**MR. G. M. ROSS' SPEECH. June 24, 1937.**

Speech of the President of the Central Board of Irrigation opening the meeting of the Research Committee on June 21.

**HOW MODELS CAN HELP : IRRIGATION PROBLEM.  
June 24, 1937.**

Describes briefly the experiment being carried out in the Punjab Irrigation Research Institute with a model of the river upstream of the Islam Weir to ascertain how straight flow

can be obtained between the guide banks of the river so that there may be no shoaling up, and 'pockets' may be kept clean.

**BUDGET DEBATE IN PUNJAB ASSEMBLY. (Extract from —). June 26, 1937.**

The Revenue Minister stated that the Haveli Project has been launched and that every endeavour had been made to obtain expert advice and that as far as possible material available in the country would be utilized.

As for the Thal project he said that the scheme had been carefully considered but not yet submitted to the Government of India. It is expected to get sanction soon.

As for the Bhakra Dam scheme he explained numerous difficulties in the way, the most important being that of securing the co-operation of Bilaspur State, 171 villages of which will have to be submerged. It is said that if Bilaspur does not agree they had an alternative of sinking tube-wells, and a special officer has been deputed to study the working of the tube-well scheme in the United Provinces.

**GOVERNMENT OF INDIA**  
**CENTRAL BOARD OF IRRIGATION**

**QUARTERLY BULLETIN NO. 7.**

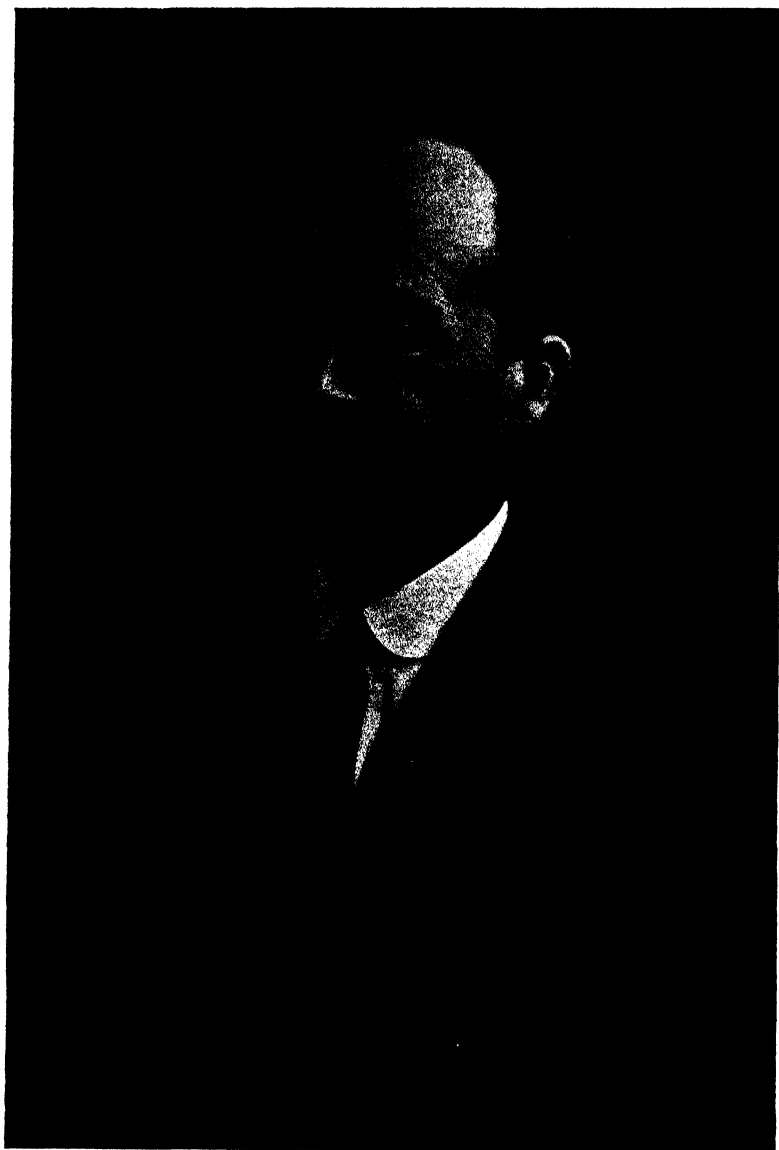
**JULY TO SEPTEMBER, 1937.**

**I.I.B.**

**532+62+83 ] 025.357(05)**

**SIMLA,  
15TH OCTOBER, 1937.**

**Mr. C. C. Inglis, C.I.E., I.S.E.**



Director,  
Central Hydrodynamic Research Station,  
Khadakvasla, near Poona.

Office of the Secretary,  
Central Board of Irrigation,

Simla, H. O.

**QUARTERLY BULLETIN NO. 7.**

**JULY TO SEPTEMBER, 1937.**

**The Board.**

As mentioned in the last Bulletin, the annual meeting of the Board will be held in Delhi from 30th October to 4th November. The President of the Board, Mr. G. M. Ross, C.I.E., will open the proceedings. The following are some of the subjects to be discussed at the meetings :—

- (i) Research Reports presented by the various Provincial Research Officers at the last meeting of the Research Committee, together with Research Committee's conclusions on special subjects.
- (ii) Discussion of the following subjects brought forward from last year :—
  - (a) Means to secure the equitable distribution of irrigation water.
  - (b) Design of weirs on permeable foundations.
  - (c) Design of canal falls.
  - (d) Waterlogging and land reclamation.
  - (e) Staunching of canals.
  - (f) Meandering of rivers.
  - (g) The development of power from canals for domestic, commercial and agricultural purposes and for the extension of irrigation.
  - (h) The fair incidence of the cost of irrigation water on different classes of crops.
  - (i) The policy of irrigation in India, with special reference to future development and finance.
  - (j) The design of channels in alluvium.
- (iii) Consideration of the following new subjects :—
  - (a) The role of reservoirs in river flood control.
  - (b) Draft Questionnaire on Drainage Systems in Irrigated Areas.



The following administrative questions may also be discussed :—

- (i) The question of appointing a successor to the present Secretary.
  - (ii) Inter-Provincial and inter-State development.
  - (iii) The advisability of separating irrigation from floods and river control.
  - (iv) Re-designation of the Board as the Central Board of Irrigation, Hydro-Electricity and Flood Control.
  - (v) Sir John Russell's recommendation for a Central Research Station for Irrigation.
2. The U. P. Govt. have invited the Board to visit the Chitaura Power Station on the 2nd of November on the occasion of the opening ceremony to be performed by His Excellency the Governor of U. P.
3. The Board may also visit the Imperial Agricultural Research Institute at Delhi.
4. The following changes in the Membership of the Board have taken place during the quarter :—

Mr. G. M. Ross, C.I.E., Chief Engineer, N.-W. F. P., and President of the Board, who had gone on leave in July last, has taken over from Mr. A. Oram with effect from the 1st of October.

Mr. C. C. Mackintosh, Chief Engineer, Burma, is returning from leave and will take over from Mr. A. A. H. Ricketts at the beginning of November.

#### **Research Committee.**

Conclusions of the Research Committee will be considered by the Board at the forthcoming annual meeting.

2. The informal winter meeting of the Research Officers will be held at Lahore at the time of the Punjab Engineering Congress, which generally takes place some time in February.

3. Dr. E. McKenzie-Taylor, Director, Punjab Irrigation Research Institute, is proceeding on leave in November.

4. The following are the provisional programmes of research for 1937-38 in the various Provincial Research Stations. (The programme of the Central Hydrodynamic Research Station at Khadakvasla has already been given in the last Bulletin on page 15).

#### *United Provinces P. W. D. (I. B.) Research Section, Programme of Work for 1937-38.*

The work of the Research Section will be mainly confined to the following groups of subjects :—

1. *Staunching of Canals and Guls.*—(a) The evidence of considerable loss occurring in a lined channel (*vide* page 6 Technical Memo. No. 6)

shows the necessity of further investigation in this direction. There are now various types of lining in existence in the Province and these will be tested for staunchness.

(b) The financial aspect of channel lining will be taken up again. Since the last attempt more data has been accumulated, and the modified losses through the lined portion will be taken into consideration. A definite reach of canal with its gul system will be analysed in full detail, and, as regards the gul system, account will be taken of the number of days the various branches run during the seasons.

(c) Experiments on channel lining will continue.

2. *Losses on Main Canals and Branches.*—(a) Examination of the statistics contained in Appendices F, and Distributary Statistics of the Supplements to the Irrigation Administration Report (Annual) will be undertaken for the Ganges Canal System to arrive at the volumes of water contributed to the tube well areas by canal seepage.

(b) Losses for Main Canals and Branches will be determined by field measurements if specific enquiries are received from Circles.

3. *Losses in Distributaries and Minors.*—Further losses will be determined mainly in connection with 1(b) and 2(a) above.

4. *Losses in Guls.*—Experiments on gul losses will continue and information as to the type of soil and clay content will be collected in each case.

5. *Silt Observations.*—Work under this head is largely dictated by the number of enquiries received from Divisions.

Records will continue to be kept of temperatures of canal water.

The silt load, which has received little attention to date, will be recorded on the Kheri Branch throughout the year.

6. *Silt Selective Heads.*—The various designs constructed in the field will be kept under observation.

7. *Model Work.*—The following cases will be examined :—

(a) Scour Below Bahadurabad Power House, Upper Ganges Canal.

(b) Scour D. S. of Karan Nadi Flume, Hathras Branch, Upper Ganges Canal.

(c) Scour below the Absara Syphon, Rohilkhand Canal Division, Sarda Canal.

(d) Protective Devices to cheapen the proposed Karan Nadi Fall.

(e) Silt Selective Heads. (This depends on the views expressed at the Meeting of Research Committee of the Central Board of Irrigation in June 1937.)

Other investigations depend on enquiries from Circles.

8. *Miscellaneous and Advisory*.—Work under this head depends on enquiries, but there are the following cases to be dealt with.

- (a) Preparation of a Report on the Records required from the Tube Well Areas for future Statistical Work.
- (b) Revision of the instructions contained in the Manual of Professional Orders on the observation of discharges in distributaries and minors. The large amount of data collected by the Research Section will be utilized for this purpose.
- (c) Preparation of Standard Design for Flumed Sections.

#### IRRIGATION RESEARCH DIVISION POONA—BOMBAY.

##### *Outline of work proposed during 1937-38.*

##### *I. Effect of irrigation on different soil types.*

- 1. Soil types in the Deccan canal tracts and their behaviour under irrigation (to be continued).
- 2. Movement of irrigation water through various types of soils moisture gradients.
- 3. Losses of irrigation water by :—
  - (1) Transpiration.
  - (2) Evaporation.
  - (3) Percolation.
- 4. Relative rise of salts in soil from solutions of various strengths.
- 5. Classification of damaged areas.

##### *II. Reclamation.*

- 6. Laboratory and pot experiments under controlled conditions with a view to reduce the cost of reclamation.
  - (a) (1) Molasses (2) Calcium setts-increasing the concentration of calcium ions (3) Sulphur (4) Alum.
  - (b) Evolution of  $\text{CO}_2$  from soil under various stages of reclamation.
  - (c) Fixing the dose of gypsum per acre for damage of various intensities.

##### *Field Experiments.*

- 7. Selection of cane varieties and other rotational crops suitable for growing during land reclamation.
- 8. Soil tilth experiments.
  - (i) F. Y. M. series.
  - (ii) Chemical treatments (Gypsum).

### III. *Experimental work at the Effluent Research Station Hadapsar.*

- (i) To ascertain whether it is necessary to discontinue effluent after cane is 10 months old.
- (ii) The maximum dose of effluent that cane can withstand without reducing the outturn or deteriorating the quality of gul.
- (iii) Whether it is essential to dilute effluent before applying to crops.
- (iv) The effect of Fallow effluent treatment for soil before plantation of cane.
- (v) Cane varieties suitable under effluent irrigation.
- (vi) Cane varieties suitable for seasonal plantation.
- (vii) Effect of effluent on various types of soils.

### IV. *Miscellaneous.*

- (i) Liquid mud.
- (ii) Reducing losses in channels by sodiumising the sides.

## PUNJAB IRRIGATION RESEARCH INSTITUTE.

### PROVISIONAL PROGRAMME OF WORK FOR 1938.

#### I. *Chemical Section.*

(1) *Movement of Salts and Moisture in Soils.*—The work proposed on this subject is in continuation of that already reported in the Annual Report for 1936-37. Particular attention will be paid to the effect of atmospheric humidity on the movement of salts and the moisture content of the soils. An intensive examination of a small area in the field will be made to determine the influence of the water-table and other factors on the movement.

(2) *Soils Mechanics.*—During the past year, considerable progress had been made in the experiments for preventing seepage losses. It has been found that a 4" layer of soil treated with sodium carbonate is impermeable under a head of 13'. Chief Engineer has ordered that certain distributaries should be treated during the cold weather. These experiments will be carried out.

The effect of sodium carbonate treatment during the manufacture of bricks has also been under examination. Further experiments will be carried out to determine the effect of the treatment on the strength of the bricks and on their porosity. The increase in the strength of the bricks and the reduction in their porosity should have important applications.

A grant has been received from the Government of India for the study of earth roads. It is proposed to investigate the effect of the exchangeable bases on the soil properties, the methods for the control of salt movement and the part played by clay and other fractions in the soil in consolidation. Methods for testing the properties of the soil from the point of view of roads will be worked out.

(3) *Alkali Soils*.—Further investigations will be undertaken to determine the amount of gypsum required to prevent the deterioration of soils and also the quantities that must be used at various stages of deterioration to restore the soil to its original condition.

(4) *Methods for the Examination of Soils*.—An attempt will be made to develop methods for the rapid and accurate determination of the chemical and physical properties of soils.

## II. *Physics Section*.

(1) *Seepage*.—Investigations will be continued to determine the relation between the seepage from the canal and the depth of the Water-table. Experiments on this subject are already in progress at Renala. In this connection a method is now being developed for the determination of the transmission co-efficient of fine materials using air instead of water.

(2) *Tube-Wells*.—In collaboration with the Officer on Special Duty, Tube-Well Investigations, a number of subjects have been drawn up for study in the Physics Section. Among these are the relation of discharge to the following :—

- (a) Length of strainer,
- (b) Position of strainer,
- (c) Diameter of strainer,
- (d) Draw down,
- (e) Shrouding,
- (f) Type of strata.

Experiments are already in progress on a number of these points. It is also hoped to carry out experiments in the field on the above subjects.

(3) *Pressure on Retaining Walls*.—The apparatus for determining pressure on retaining walls has been developed and investigations on this subject in model form will be carried out during the year. This subject is in continuation of the uplift pressures on weirs.

(4) *Defects under Weirs*.—This is in continuation of the programme for 1936-37. The apparatus for the transmission of ultra short waves has been perfected. It is hoped during the year to complete the construction of the receiving apparatus and to carry out tests so as to perfect the method for field use.

(5) *Soil Mechanics*.—This subject is being developed in connection with angle of repose and erosion. Experiments are to be carried out to study the effect of clay and other fine materials on cohesion and on other factors which determine erosion.

## III. *Mathematical Section*.

(1) *Movement of Silt and the Regime of Channels*.—The data which has been collected during the past four years is now under examination and it is hoped to derive relationships which will express the effect of silt

on regime. When these relationships have been formulated it is proposed to test them out at further sites which will be established and some of the present sites abandoned.

(2) *Experiments on the Models of the Rivers and Works in connection with the Haveli Project.*—A model of the rivers Chenab and Jhelum above and below their confluence has been constructed and the following are to be examined :—

- (a) The position and size of the bunds necessary during construction period.
- (b) The position, length and form of the guide banks that would be necessary.
- (c) The position of the leading cuts to divert the river on to the weir.
- (d) The effect of the weir on the river and the training works that would be necessary for river control.

A model of the weir, left undersluices and canal regulators has been constructed for the examination of the best form of silt excluder and for the scour downstream. A model has also been constructed to determine the effect of the groynes on the scour downstream and the afflux upstream. An investigation will also be carried out regarding the designs of the silt ejectors in the canals.

#### IV. Statistical Section.

(1) *Studies in Subsoil Flow under Irrigation Works.*—The following theoretical investigations connected with the problem of weir design will be carried out in continuation of the work of 1936-37 :—

- (a) An examination of Lane's 'weighted-creep' theory.
- (b) Subsoil flow under a depressed floor.
- (c) Pressure distribution under a floor with equal end piles and a changing intermediate pile—An empirical extension of Khosla's Principle of Independent Variables.
- (d) The role of corners in irrigation structures—floors with and without corners.
- (e) A review of the hydraulic model experiments from the standpoint of streamline theory.
- (f) Subsoil flow with equal piles at heel and toe of a flush floor.
- (g) The comparison of thick cut-offs like well-lines or curtain walls with thin cut-off like steel piling.
- (h) Effect of uniform downstream or upstream scour on flow under a depressed floor.
- (i) The design of sloping floors with reference to uplift pressure.
- (j) The flow under a depressed floor fitted with equal end piles.
- (k) The flow under a flush floor fitted with unequal end piles.
- (l) The flow under a depressed floor fitted with a central pile.

(2) *Rainfall—Run-off Studies.*—The relation between the winter supplies in rivers and the date of the stoppage of monsoon in the catchment will be investigated to trace the probable effect of the increase of denudation in the foot-hills.

(3) *Silt Problems.*—It is hoped to examine the effect of temperature on silt movement in stable channels under regular observation, and of the regulation at headworks on the silt entry into canals.

(4) *A Study of Salt-afflicted Villages.*—The conditions in a number of villages afflicted by salts will be studied and the factors influencing the extent of area irrigated each year will be analysed. This is in continuation of work already in progress.

#### V. *Hydraulic Section.*

It is difficult to give a definite programme of work in the Hydraulic Section as this is determined by the models required by the Chief Engineer. The work to be continued consists of the examination of the Trimmu Weir Models in connection with the design of the weir and its protection downstream. Orders have also been received for the examination of the conditions of the working of the undersluices of the Rasul Weir. The Falls at Pakpattan Canal are also to be examined so as to provide protection against scour downstream and bank erosion.

The examination of the River Sutlej at Islam will be continued with the object of determining the training works necessary to prevent bela formation between the guide banks. It is also proposed to examine a model of the river Chenab at Khanki to determine—

- (a) the supplies in various parts of the river that will result in the minimum silt entry into the canal in summer and winter.
- (b) the regulation of the undersluices which will result in the optimum silt distribution.
- (c) the effect of the method of regulation on bela formation upstream.
- (d) the methods to be adopted to obtain the greatest advantage in undersluices in Bay 4 of the weir.

#### VI. *Land Reclamation Section.*

(1) *Reclamation of Thur Land.*—(a) Observations on the crops obtained from reclaimed 'thur' land indicate that if a proper rotation of crops is adopted after reclamation there is no decline in yield. These observations will be continued in 188 N. B. Lower Jhelum Canal.

(b) A fresh experiment on the reclamation of 'Thur' land belonging to R. B. Sardar Basakha Singh in Lower Bari Doab Colony has been sanctioned by the Chief Engineer. This will be started during the year.

(2) *Prevention of Land Deterioration.*—(a) The experiments already in progress at Kot Ranjit, Chak 7, and Garjakh in the Upper Chenab Canal area will be continued.

(b) With the approval of the Chief Engineer an experiment in this respect, is being started by Raja Narendra Nath under the direction of the Institute. It is proposed to make a survey of fields which have begun to give low yields of wheat. These will be treated with gypsum on the basis of their calcium deficiencies and the effect on the yields of wheat studied.

(3) *Soils Surveys.*—(a) *Surveys by means of Aerial Photographs.*—Some preliminary work in the possibility of using aerial photographs for classifying the various types of soils in cultivated areas was done during the previous year. It is hoped to utilize these photographs for making a soil survey of project areas for colonisation and settlement purposes. Investigations may also be carried out on the other uses to which these photographs can be put. Calculations show that a survey by means of aerial photographs is much cheaper than that done by the field staff on the ground.

(b) An intensive study of the Sem and Thur conditions of 14 villages in the Sheikhpura District has been undertaken in co-operation with the Statistical Section. This will be continued.

(c) Twenty-five villages situated on two lines across the Rechna Doab with varying water-table depths have been selected. It is proposed to submit them to Special Thur Girdawries every five years and study the rate of the deterioration of land on the basis of an efflorescence at the soil surface in the winter months.

(d) For determining the effect of the Deg Diversion in the Upper Chenab Canal Area, 24 villages situated on either side of the abandoned Main Line Lower have been kept under observation. A survey will be made every five years.

(e) Before the commencement of irrigation in the Lower Bari Doab Colony a soil survey of certain portions of it was done. It is proposed to select certain villages in the head reach and make a further survey to compare the condition of the land now when the water-table has risen with that at the commencement of irrigation.

(f) In co-operation with the Settlement Officer a history of the development of Kallar in certain villages in the Amritsar District is being worked out from the Patwari's records.

(4) *The Distribution of Salts and Moisture in the Soil Profiles under Irrigation.*—(a) Profiles have been exposed to the water-table in the Rechna Doab and the Bari Doab and their examination has thrown considerable light on the effect of irrigation on the movement of salts and moisture in the soil. From the data obtained it is possible to identify soils which are likely to deteriorate early and those which are likely to deteriorate late.



It is proposed to continue this study and examine profiles from some other areas.

(b) An area near Jaranwala has been acquired and the land has been divided into blocks. Each block is put under a different system of cropping. The distribution of salts and moisture in the soil is studied after every crop. The water-table in this area is rising. It is hoped to obtain from this experiment information on the type of cropping which would prevent the appearance of 'Thur' at the surface. This work will be continued.

(c) Samples of soil are being taken twice a year from some plots selected for experiments on the prevention of land deterioration. It is proposed to carry this over a period of years. From this it will be possible to work out the variation in the salt content and pH value from year to year.

(5) *Study of Soil Profiles with reference to their Natural Flora.*—So far, this study has been confined to the soils and the natural flora of west Punjab. It is proposed to undertake a similar study of the unirrigated tracts of the south eastern portions of the Province.

(6) *The Rise of Water-table in the Rechna Doab.*—Water is rising rapidly in the Lyallpur District. Difference of opinion exists as to the cause of this rise and the source of this water. It is proposed to investigate the following :—

- (a) Is the water being transferred from the upper portions of the Doab through a deep coarse sand layer? If so, what is the rate of this transmission?
- (b) Is the pressure gradient the main factor responsible for the rise of water-table in the Lyallpur area?
- (c) Is seepage from canals in the area an important factor?

In addition it is hoped to re-examine the water-table records of the upper portion of the Rechna Doab to determine whether they are registering true water-table or only the pressure gradient.

(7) *The Determination of Soil Erosion and Run-off Intensity.*—Experiments on this subject have been in progress at Madhopur in land with slope 1 in 4. These will be continued. In co-operation with the Research Officer, Forest Department, a second site near Nurpur has been equipped with the necessary apparatus and measurements have been started. These will also be continued.

(8) *Measurement of Run-off in the Catchment Areas of Drains.*—No information exists regarding run-off in areas where surface drainage is necessary to prevent the rise of the subsoil water. In the absence of this information it is difficult to fix the capacity of the drains. Experiments have been started in three areas in the Rechna Doab to determine run-off. On account of the failure of the monsoon it seems it may not be possible to obtain enough data this year. It is proposed to carry out the experiments again next year.

(9) *Tube Well Irrigation*.—At the request of the Officer on Special Duty, Tube-well Investigations, an intensive study of the present practice of well irrigation in various parts of the province and the probable changes in cropping intensity that would result if tube well irrigation is introduced has been started.

## VII. General Section.

(1) *Examination of Soils from Waterlogged Areas in the Canal Irrigated Parts of the Punjab*.

(2) *The Study of the Fundamental Properties of Soils*.

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## SIND.

*Programme of work in the Development and Research Division, Karachi, for the year ending May 1938.*

It is proposed to carry out the following work during the current year :—

- (i) Model experiments.
- (ii) Further experiments in connection with Back water effects, if found practicable.
- (iii) Further investigation into methods of silt sampling and the investigation to determine a method of calculating the quantity of silt entering a channel.
- (iv) Examination and correlation of Hydraulic data and silt analysis.
- (v) Collection of Hydraulic data on Rohri Canal and its off-takes, with a view to find out Lacey's silt factor for the Rohri Canal System.
- (vi) Investigations into the movements of sub-soil water-table in Sind.
- (vii) Determination of areas (from salinity contour plans) which are likely to have been affected by the rise of salt to the surface due to the rise in sub-soil water-table having a high salt content; and reclassification of such lands to see the extent of deterioration, if any.
- (viii) Experiments to determine the absorption and evaporation losses passing through different soils in Sind.
- (ix) Usual Laboratory work.

## Board Publications.

1. Revised edition of "Glossary" (Pubn. No. 5) is still under preparation as replies from some officers are still awaited.
2. "Design of Weirs on Permeable Foundations" (Pubn. No. 12) is still in the press but is expected to be issued shortly.

3. The question of publishing Mr. P. Claxton's Note on "Silt Load on the Behaviour of Rivers" as a Board Publication will be considered by the Board at the forthcoming meeting.

4. The question of publishing Mr. C. C. Inglis' report on his experiments with the design of falls as a Board Publication will also be considered at the forthcoming meeting of the Board, if the report is ready by that date.

5. The recommendation of the Research Committee that the U. P. Govt. should be asked to place Mr. Gerald Lacey on special duty to write a publication on the Design of Channels in Alluvium will be considered by the Board at the annual meeting.

6. The Annual Report (Administrative) of the Work of the Board for 1936-37 (Pubn. No. 15) was distributed to Members of the Board and others concerned.

### **Works Section.**

#### **MADRAS.**

#### *Drainage Outlet at the Mouth of the Mangalavani Chinka at its Outfall into the Puligedda Arm of the Kistna River.*

The Kistna left flood bank crosses at 45/1 the Mangalavani Chinka (a drain with a catchment of 16.5 sq. miles) at its outfall into the Puligedda arm of the Kistna river. At this crossing, a reinforced concrete outlet sluice with automatic flap shutters to keep out river floods, has been built.

The outlet consists of 8 bays 6' to 10' wide with three counterforts (or piers) 2' thick and four others 1' thick and 17.7' high. R. C. breastwalls are provided in the bays down to the lintel slabs in the two central bays, and to the bed slab in the other bays. The bed slab 15" thick is rigidly tied to the eight twin octagonal wells (8' outer and 5' inner diameters) on which it rests. The pressure on the bed slab is not uniform, as the two central bays have to bear water pressure, while the other bays have only earth pressure. The bed slab has therefore been designed as three units with 2 butt joints connected by bent copper strips to form a flexible joint. These joints are carried right through to the top of the breastwall. A roadway 8' wide between kerbs is provided on the top. Abutments and wings have been avoided as the structure projects well into the bank. Its total length is 78'.

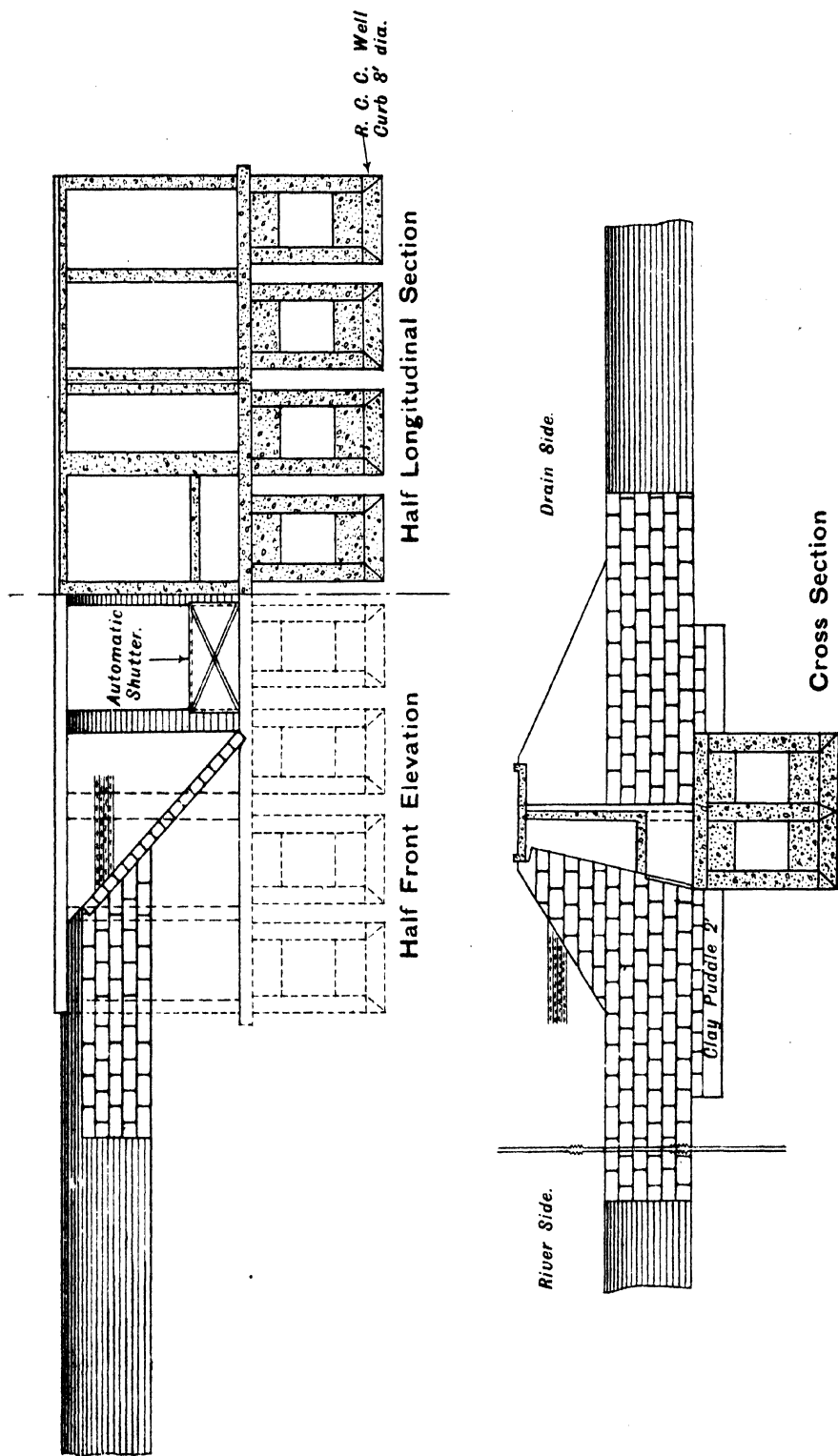
The factors that weighed in the adoption of a reinforced concrete design are (1) comparative cheapness, (2) the short period available for work and (3) availability of a competent contractor skilled in reinforced concrete work.

Estimated cost of the work is Rs. 37,500.

The design of the Outlet is shown on the adjoining page.

*Campbell Aqueduct across the Puligedda Arm of the Kistna river.*

# **DESIGN for a DRAINAGE OUTLET** **at the MOUTH of MANGALAVANI CHINKU at $\frac{1}{2}$ of KISTNA LEFT FLOOD BANK.**



2. *Guniting the Anderson Weir Wall.*—The Anderson Weir wall is made of mass concrete. The surface of the Weir became rough and it was decided that  $\frac{1}{2}$ " thick cement plaster be applied to the Weir wall by the Guniting process. The total area treated by the process is 65,874 sq. ft. at a cost of Rs. 15,204. A 3:1 mixture was applied under air pressure of 15 to 20 lbs. per sq. inch.

#### BOMBAY.

##### *Improvements to Phaltan Sangvi Road.*

Between Phaltan and Sangvi where communication is necessary between Phaltan and Baramati, it is proposed to join the irrigation tracts of Nira Right Bank Canal and Nira Left Bank Canal. The junction is to be effected by bridging the Nira river and improving the existing road between the two places. The existing road is impassable for the greater part of the year and it is desirable to facilitate the traffic between the two places. The designs of the bridge, road and drainage works are in hand.

#### BURMA.

##### *Nwadet Link Canal and Auxiliary Works.*

The Burmans threw weirs across rivers to feed their canals exactly as we do now, but they were not experts at masonry works and so left the heads of their canals open. The Zawgyi river in the Kyaukse district was dammed up in this way and in course of time the open headed canal enlarged till eventually it took practically the whole of the normal discharge of the river, the small amount escaping into the original bed being used some distance downstream to irrigate what is now known as the Nwadet and Kunze branch canals.

With the annexation of Upper Burma the original Zawgyi river was mistaken for a canal which was named the Nwadet canal and a regulator was constructed where the Burmese weir existed, the Zawgyi continuing to flow down the enlarged Burmese canal. Since then considerable damage has been done to the Nwadet Canal in years of exceptional flood, since all excess water finds its way along what is obviously its natural drainage line.

The Nwadet Canal has now been abandoned and the Nwadet and Kunze branch canals are linked up to the Zawgyi river lower down its existing course from above the Ngapyang weir. The following is a description of the work recently completed.

"The Nwadet Link Canal takes off from the Zawgyi river 500' upstream of the Ngapyang weir and after cutting through a table-land of Hard Pan where the average depth of cut was 18', it turns 85° to the right, keeping this table land as its right bank for the next 6,000 feet. After this the alignment climbs on to the watershed and in a single straight line makes for the Bifurcation of the Nwadet and Kunze Branch Canals.

**Index plan of Headworks showing Franky concrete pile and steel sheet pile in connection with additions to Anderson Weir at Rondia.**

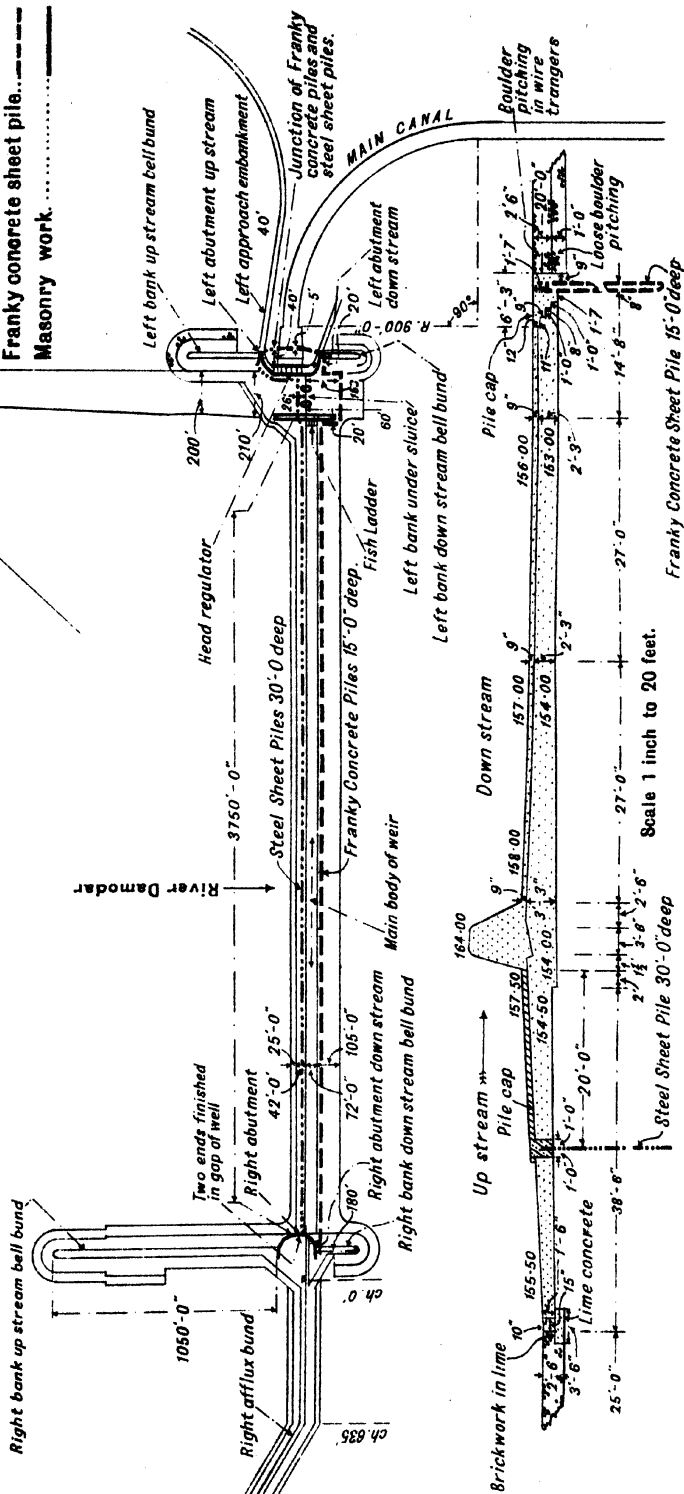
**Approximate Scale:—1 inch to 825 feet**

## REFERENCE.

## Steel sheet pile

**Franky concrete sheet pile.**

**Masonry work.**

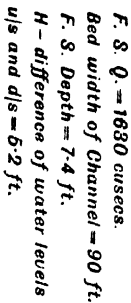


**Scale 1 inch to 20 feet.**

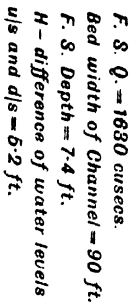
### GENERAL CROSS SECTION OF WEIR

**Scale 1 inch to 40 feet.**

1 in 6



*F. S. Q.* = 1630 cusecs.  
*Bed width of Channel* = 90 ft.  
*F. S. Depth* = 7.4 ft.  
*H* - difference of water levels  
*u/s and d/s* = 5.2 ft.



Masonry works on this Link Canal comprise five falls, five bridges, a distributary head sluice and the Head Regulator of the Main Canal. This Head Regulator was designed with its axis making an angle of  $60^\circ$  to the axis of the river with a view to reducing the induction of silt into the canal. Of the falls three have raised crests, while the other two are flumed falls with Inglis baffles, and are combined with bridges. (A design for a canal fall recently prepared by Mr. C. C. Inglis, C.I.E., is published in this Bulletin).

The existing long and unwieldy Linzin Distributary was split into two lengths. The upper half now being fed by a short length of channels which takes off directly from the river but whose Head Regulator is combined with the Head Regulator of the Main Canal in such a way that the independent control of water to either channel is provided for. The lower half of the old distributary will be supplied with water from the Main Canal at a point three miles lower down by a channel 2,600 feet long.

The Nwadet Link Canal and auxiliary works will be completed by the 20th August 1937."

#### **Information Bureau and Library.**

As mentioned in the last Bulletin, the Library was kept open up to 7-30 P.M. throughout the summer season, but few officers have taken advantage of this arrangement.

2. The following are some of the enquiries dealt with during the quarter :—

River training.

Water lifting arrangements.

Library science.

Seepage and its measurement and prevention.

Watercourse outlets.

Design of foundations for buildings.

#### **MISCELLANEOUS.**

1. The following is an extract from Sir John Russell's "Report on the work of the Imperial Council of Agricultural Research in Applying Science to Crop Production in India" :—

#### **"An All-India Irrigation Research Station".**

The development of irrigation is one of the most remarkable features of modern India. Three sources of water are used :—

- (1) canals from the great rivers—either snow fed rivers, or rain fed, and therefore requiring storage arrangements;
- (2) wells from the underground supplies in the plains;
- (3) tanks filled by rain or streams trained down into them.



The area now irrigated is very large. Out of 227 million acres sown in British India in 1934-35, 50·5 million were irrigated; practically half (26 million acres) from canals, and one quarter (12·5 million acres) from wells; further schemes are being discussed. A striking development is the combination of irrigation works with the generation of electricity which promises to effect marked changes in the life of the larger villages and smaller towns.\*

The supplying of water to the cultivator is the business of the irrigation engineer, and is usually well done in India. Two of the large provinces where irrigation is important, the Punjab and Bombay,† have Research organisations and other provinces have Research Officers who, however, are not infrequently charged with other duties also.

But the supplying of the water is only a part of the problem. A much more difficult matter is to use it advantageously so as to ensure permanent benefit to the district, and repayment of the heavy capital costs. When a great dam or barrage has been opened with much ceremony and flourish of trumpets it must always be remembered that the problems still remaining are greater than those already overcome because they are more continuous, more subtle, and much less under the control of the experimenter.

Three great groups of agricultural problems arise.

(1) Selection or if necessary production of new varieties of crops suited to the new conditions. New selections and hybrids are produced in many parts of India and interchange should be freely arranged between the various staffs concerned. The final selection must necessarily be made in the region where the crop is to be grown.

(2) The designing of the new cropping schemes. Usually the water supply is not entirely continuous but more is available at some seasons than at others. The cropping has to be so arranged that the best use can be made of the water and of the man and bullock labour available. Much more attention should be paid to this troublesome problem of arranging a sequence of crops at once profitable to the grower and permitting the best use to be made of the water. The potential improvement is shown by the fact that even now some cultivators succeed in making the water go much further than others: some of the Punjab sequences are admirable: while some of the larger cultivators have worked out methods that deserve detailed study and trial elsewhere.

In canal irrigation the water must be taken when it is given and the cropping scheme adjusted to the supply available. In planning a new canal irrigation project, therefore, the proposed cropping scheme should be as fully and as carefully considered as the engineering details.

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\* The Meerut tube well scheme under the supervision of Sir William Stampe is a notable example of a well planned effort to combine water supply with electricity and with such amenities as bathing and washing facilities.

† Irrigation is chiefly by canals in the Punjab and from tanks in Bombay. The Bombay schemes are largely concerned with prevention of famine.

Where the water is supplied from tube wells greater control of the supply on the individual farms is possible, and therefore greater flexibility in the cropping scheme. Another set of problem then arises : the best times to supply the water to each crop and the optimum quantities to give.

These problems are fairly straightforward and present no special peculiarity.

The soil problems, however, are much more difficult, especially in regions of canal irrigation. Waterlogging and neutral salts can be dealt with, though the treatment may be very costly, but behind every large irrigation scheme there lurks the spectre of the alkali problems, for which in its final stages no economic solution has yet been found. Well designed experiments would no doubt suggest methods of dealing with the incipient stages when action is possible, and these should certainly be undertaken as early as possible. Constant watch should also be maintained to ascertain whether the salted and waterlogged areas are increasing or decreasing. Photographic aerial surveys would probably be the speediest and most effective means of doing this.

It may be laid down as an absolute rule that no irrigation scheme should ever be carried out until a proper soil survey of the region has been made. Areas containing salt or liable to serious waterlogging should only be brought into the scheme after consideration. This may necessitate a survey of the floor of the region, as described on page 128. A good preliminary survey reduces the risk of trouble to a minimum : but it is always there and on some of the existing schemes it is considerable.

All the various problems concerned are being studied at some or other of the Research Institutions, but the work is scattered, it is uneven in quality and in scale, and it lacks unified direction. I strongly recommend the establishment of a Central Irrigation Research Station to undertake investigations on all agricultural problems associated with irrigation, and to supervise or be closely linked up with other irrigation investigations supported by the Council. The Station must be situated in the heart of a large irrigated area : the Punjab or Sind are obvious possibilities, probably the Punjab would be better as it could there be closely associated with the existing Institution at Lahore and with the college at Lyallpur.

But I cannot too strongly emphasise the difficulty of the work and the necessity for choosing the staff solely on the ground of their ability to do it. Suitable men are extremely scarce, and any restriction on the choice is likely to prove fatal to the scheme.

The Lahore Institute would remain as at present the centre for engineering research. It is so well staffed that it could probably widen its scope and undertake research on the surfacing of earth roads in rural districts, a subject which is not so remote from its present work as

might at first sight appear. I suggest that the Council consider the advisability of discussing this possibility with the Irrigation Department."

2. The following are some items of interest in the Punjab :—

- (i) Work on a few experimental tube wells is in progress; from these it is intended to obtain information on which the future of tube well irrigation in the Province may be judged.
- (ii) Progress continues with the drainage systems for the northern part of the Punjab irrigated area. It is hoped that these drains will materially assist in stabilising the rising sub-soil water table.

Experiments in connection with the staunching of channels on an increasingly larger scale continue to be made with the object of obtaining final and conclusive evidence of the value of the sodium carbonate treatment.

- (iii) In Northern Punjab the Monsoon has been very meagre and river discharges lower than usual. The reconstructed Marala Weir has functioned satisfactorily though it has not yet been very highly stressed this summer.
- (iv) Water surface slopes are being observed on the Western Jumna Upper Main Line and Lower Main Line to watch the effect of silt exclusion at Dadupur on the bed and water surface slopes of the Canal below Dadupur. Similar data is being collected on the Upper Bari Doab Canal in view of the construction of a silt excluder at its head in the next winter.
- (v) Experiments were made at the Malikpur testing station on the Upper Bari Doab Canal to arrive at the width of cantilever slab required to keep shingle out of the canal. The slab will be constructed during next winter.
- (vi) Work will be commenced shortly on the construction of a link canal, capacity 700 cusecs, from the Lower Bari Doab Canal near Montgomery to the Pakpattan Canal. This link canal will enable water set free in the Ravi by the Haveli Canals Project to be utilized in the Nili Bar Colony of the Sutlej Valley.
- (vii) It has been decided to put a line of sheet piles below Islam Weir, and the work, which will cost about Rs. 3½ lakhs, will be carried out this winter.
- (viii) Very interesting experiments have been carried out at Malikpur to study the layout of Guide Banks and arrangements for Diversion Cuts for the proposed Trimmu Headworks. The results obtained from the model are considered to be very satisfactory indeed; details of the

experiments and the results achieved will issue in a separate publication. Further experiments at Malikpur are in progress to study the effectiveness of various devices for excluding silt from entering canal heads.

- (ix) Work on the Trimmu Headworks has been commenced. The canal Railway line from Mudduki to the Station areas has already been laid. Tenders for Trimmu Barrage gates were received from eight firms. The contract has been given to the Public Works Department Central Workshops at Amritsar. Tenders for opening a new Quarry at Sikhanwala to supply stone for the Haveli Project have been accepted.
- (x) The second circle of the Haveli Project has also been opened with K. B. M. Iqbal Hussain as the Superintending Engineer. The work in this Circle will mostly comprise of remodelling of the existing Canals of the Sidhnai and Chenab Inundation series.

(xi) The Thal Canal Project is still under further investigation.

3. The U. P. Weeekly Progress Report on Research mentions the following items of interest :—

- (i) The Bulandshahr Power House Model Experiments for determination of scour have been finished and the report is under preparation.
- (ii) Draw-down curves for certain tube wells for determination of transmission coefficient are under preparation.
- (iii) The preparation of the modified Etcheverry instructions for the design of flumed structures using constants determined by discharge observations on the Karon Nadi Flume is in hand.
- (iv) A Jesson type of metering flume has been constructed on the Dehra Distributary, Ganges Canal, in accordance with U. P. Design No. 272 R. D. 2, given in U. P. Technical Memorandum No. 6, and it is stated that the weir metered perfectly with as low a loss of head as 0.15 ft., the depth of the water over the crest being 1.4 ft. It is now proposed to construct a similar flume on the Mat Branch to deal with a maximum discharge of 1710 cusecs.
- (v) Rehbock sills have been fitted to the new falls on the Kheri Branch.

4. In the United Provinces plots of light usar in the lower portions of the Sarda Canal are being reclaimed in conjunction with the Agricultural Department. To date, approximately 400 acres have been taken up. The process consists of sowing sun hemp with canal water in May and afterwards ploughing in and sowing a salt resisting rice. Water is given free to land owners for two years to encourage them to break up their light usar land, and the results to date appear promising.

5. It has been learnt from the Director of Irrigation, Ceylon, that they have adopted the Lacey Formulas for designing and remodelling channels in Ceylon.

6. The lower reach of the Tisza river in Hungary has been reduced in length from 700 to 435 miles—38 per cent—by 112 cut-offs. (For further particulars see the "literature" section).

7. Mr. M. R. Richardson, Chief Engineer, U. P., Mr. J. D. H. Bedford, Chief Engineer, Punjab, and Mr. A. Gordon, Chief Engineer, Sind, will represent the Board at the next meeting of the Crops and Soils Wing of the Board of Agriculture and Animal Husbandry in India, to be held at Lahore in December 1937.

8. Mr. C. G. Barber, C.I.E., M.B.E., Officiating Superintending Engineer, P. W. D., Madras, who was on leave in England, attended the annual meeting of the Executive Council of the International Commission on Large Dams held in Paris on 28th June 1937 as a delegate of the Central Board of Irrigation. Mr. C. B. Pooley, C.I.E., the honorary representative of the Board in England also attended.

9. Mr. R. T. Harrison, formerly Chief Engineer in Bombay, was invested with the insignia of the C. S. I. by His Majesty the King at Buckingham Palace on the 13th October, eight years after it was awarded. Mr. Harrison has been in Jamaica since he retired.

### Literature.

The following literature was received during the quarter.

*Readers are reminded that they are at liberty to borrow any of the literature in the Board's library, in accordance with the rules published in Bulletin No. 3, and to submit enquiries on any matter dealing with irrigation and allied subjects.*

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## CIVIL ENGINEERING AND PUBLIC WORKS REVIEW.

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## UNDERGROUND WATER SUPPLIES.

At the forty-second general meeting of the Institution of Water Engineers, the President made some remarks regarding the urgent need of restricting the unscrupulous exploitation of underground water resources in Great Britain. As the law stands, it is open to any property owner to sink any number of wells in the near vicinity of the works of a water undertaker and by abstracting water without limit for his own purposes, to cause shortage in the public water supply without the water undertaker having any redress. The result of this indiscriminate exploitation of underground water is evidenced by a steady drop in water level which is taking place in a number of artesian and semi-artesian basins, which is giving cause for serious alarm. A restriction of the quantity of water pumped out is becoming increasingly necessary.

## FOREIGN NOTES.

## BRIDGES ON GERMAN MOTOR ROADS.

Two German bridges are briefly described. One of them is a reinforced concrete girder bridge of the continuous type, having 3 spans of 72 ft. 97 ft. and 72 ft. respectively. The girders are 2.5 ft. thick and their underside is curved.

The second bridge consists of a reinforced concrete deck carried on cross girders which rest on solid spandrel arches. There is no bracing between the spandrels and the structure has a light appearance. The spandrel arches are 2.1 ft. thick and at 19.7 ft. centres. There are five spans varying from 82 ft. to 92 ft.

## A DIFFICULT SHEET PILE FOUNDATION.

The construction of the right bank pier of a bridge over the Rhine at Duisburg is briefly described. The pier was constructed within a sheet pile cofferdam. The interlocking piles were of 32—38 ton steel, 56 ft. long and were driven to 50 ft. below mean water level, the bottom of the foundation excavation being 40 ft. below mean water level. A 4 ton steam hammer with a stroke of 4 ft. was used and the minimum penetration per blow was .02 in., some piles requiring 5000 blows.

## LAND RECLAMATION WORKS IN GERMANY.

A ten year plan for land reclamation on 150 miles of coast is now in course of execution in Germany. A total area of 1,250,000 acres representing a strip 13 miles wide on the 150 miles of coast lies within the scope of the work. A chain of islands representing the mediæval province of Freisland lies a short distance off the coast and the object of the reclamation work is to recover all the land between the islands and the mainland. The method of reclamation being followed is to form large sheltered areas by the construction of stone pitched dams which frequently serve to connect the mainland with the islands. Within the sheltered areas smaller enclosures 400 yds. wide are formed by means of double rows of piles with mats anchored with stones in between. These areas are allowed to silt up. A drainage system is provided to take away the water rapidly so that the newly deposited silt may get consolidated before the next tide.

## THE VIBRATION OF CONCRETE.

Walsh.

Vibration as a means of consolidating concrete is rapidly becoming more commonly used. There are two main reasons for this :

1. The reduction of labour in placing and compacting concrete.
2. The satisfactory placing and compaction of concretes that are too stiff for consolidation by tamping. A stiff mix with low water cement ratio results in high strengths and densities.

This article describes five different methods of applying vibration to concrete, namely the vibrating table, external vibration, surface vibration, internal vibration, and combined surface and internal vibration. A few types of vibrators are described, and the advantages of various methods of vibration are discussed. Frequencies suitable for different methods of vibration are mentioned. In a U. S. Government work at Davenport comparison was made between hand placed concrete and concrete placed by internal vibrator, and it was found that with the same water cement ratio both the cement and the sand in the mix could be reduced without detriment to the quality.

A special form of surface vibrator has recently been developed in France for compacting and finishing concrete protection on the side slopes of canals and reservoirs. Working on a side slope of 2:1, one of these machines placed 290 sq. yds. of cement 6 inches thick per day of 8 hours. The surface finish was good and required no trowelling. Outputs of vibrators as obtained in the London area are given. In conclusion the author gives a summary of recommendations for the use of external, internal, and surface vibrators which will be very useful in practice.

## THE FACTOR OF SAFETY IN PILE DRIVING.

Allin.

The pile driving formulæ which have been in general use up to recent years usually contain constants varying between 6 and 12 selected by their authors as factors of safety. This procedure was justified in view of the empirical character of the formulæ. But in modern rational formulæ there is no reason why a more discriminating choice of a factor should not be made so as to suit individual conditions. The rational impact formula for piles is based on certain assumptions which are not fully justified. There is thus a gap between theory and practice and this article discusses some aspects of this gap with a view to discover means of bridging this gap by practical measures and suitable adjustment of the factor of safety. The main discrepancies between theoretical and actual values of resistance to penetration for cohesive and non-cohesive strata are explained and allowances to be made for factor of safety are given.

BELLMOUTHED WEIRS AND TUNNEL OUTLETS FOR  
DISPOSAL OF FLOOD WATER.

Binnie.

Extracted from a paper read before the Institution of Water Engineers. Early applications of this type of overflow date back to 1896 and in many cases the use of this type has resulted in considerable reduction of costs. A table giving particulars of various designs of bellmouth overflows used in a number of actual works is included.

In designing several of these, model experiments were undertaken to determine the best shape of the bellmouth and also to determine their behaviour under operating conditions. The experiments carried out for the Jubilee reservoir in Hong Kong are described in some detail and the conclusions arrived at given. Other experiments and improvements carried out as a result are also mentioned.

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## NOTES OF THE MONTH.

## ROAD RESEARCH.

The second annual report of the Road Research Board for the year ended March 31, 1936 has been published. Many road failures have been shown to be due to the foundations giving way. The report describes tests which have been devised to investigate the characteristic properties of soils. Flaky and elongated material is unsatisfactory for road construction. Practical methods for studying and measurement of the shape of road aggregates have been devised.

In concrete roadwork, it is extremely difficult to secure a rigid control of mixtures, especially with reference to the water content. Three road testing machines are being used to find the relative strength of different bituminous constructions. A standard machine consisting of a motor cycle with sidecar has also been developed for the study of skidding.

#### AIR CONDITIONING IN THE TROPICS.

A new and economical method of insulation against radiant heat by means of reinforced aluminium foil has recently been demonstrated. As a result of experiments carried out it has been possible to produce a portable cubicle, coupled with a small air conditioning unit which can be plugged into an ordinary electric supply, and so enable the conditions inside the cubicle to be kept at an even temperature and humidity, irrespective of the surrounding conditions.

#### STRUCTURAL WELDING : A STUDY OF GERMAN PRACTICE : SIGNIFICANT CONTRASTS.

Bondy.

Describes three types of welded building structures now being erected in Germany and deals with the principal features of the three types. Formulæ required for the design of a few types of two pin structures which are the most common and favoured types of welded construction in Germany are given.

#### THE BEHAVIOUR OF PILES IN COHESIVE SOILS.

Allin.

When re-driving piles after a period of rest into water bearing cohesive soils of low permeability such as soft clay, loams, and fine grained silts, the resistance to penetration of the piles shows an increase of value. Such is not the case in highly permeable and non-cohesive strata. The period necessary for the full resistance to develop after driving is estimated between one and two days and varies with the moisture in the soil and its degree of permeability. The author discusses the causes of this phenomenon in the case of clay and considers whether this improved resistance of the pile after a period of rest should be taken advantage of in design. This improved resistance is to be ignored in the design of piles subjected to shock or vibration but may be taken advantage of where piles are not likely to be subjected to any disturbance.

#### SINKING MONOLITHS AND CAISSONS IN COMPRESSED AIR.

Cogdon.

For building concrete quay walls in deep water, sinking of monoliths or caissons in compressed air is the most adaptable to any circumstances but the cost of this method is very high. The principal advantage of the method is

that the foundations of the proposed structure can be inspected in their natural state. The essential features of a caisson are described and the steps in the sinking of a caisson from the pegging out on the site to the completion of sinking operations and filling with concrete are described, and the precautions necessary in sinking the caissons are mentioned. Principal features of the compressed air plant are briefly described. Special reference is made to two types of monoliths and caissons used recently in the construction of a deep water quay. The design of these monoliths and caissons is described and an account of their sinking is given. They were sunk through magnesium limestone with a mean rate of sinking of 1 to 2.75 ft. per 24 hours.

#### THE EXAMINATION OF WELDS BY X-RAYS.

Schons.

Describes a recent development of testing welded joints by X-Ray apparatus.

#### THE LATERAL FORCES ON STANCHIONS IN SINGLE STORY BUILDINGS.

Voce.

This is the concluding article of a series which appeared in previous issues. Certain diagrams are given from which deflection factors can be calculated to obtain deflections in different types of stanchions. The use of the diagram is illustrated by several examples.

#### TESTS ON SHRINKAGE OF CONCRETE.

Shank.

Results of certain experiments with plain concrete and reinforced concrete specimens for the determination of shrinkage and shrinkage stresses are given in this article. The specimens were made of concrete having five different cement water ratios and measurements were taken over a period of 500 days. The results are shown graphically and are analysed and discussed. Some of the conclusions arrived at are :

1. Richness and strength have no apparent effect on the shrinkage.
2. There is a sudden change in the rate of shrinkage at some time after exposure to dry air, about two months in the case of the specimens concerned.

#### NEW DIAGRAM FOR THE DESIGN OF CHANNELS.

A diagram is given from which dimensions of channels of capacities from 0 to 3000 cusecs having 1 to 1 side slopes and a value of Kutter's  $N = .030$  could be quickly and accurately determined. Corrections are given at the top of the diagram which enables channels with other side slopes and values of  $N$  to be worked out. Several examples illustrating the use of the diagrams are worked out.

*No. 374—August 1937.*

## NOTES OF THE MONTH.

### NEW WATERLOO BRIDGE.

The new Waterloo bridge, the construction of which will shortly commence consists of 5 spans of 238 ft. Each span will consist of twin arches side by side with a flat soffit 33 ft. wide between them. The arches and flat soffit will be of reinforced concrete. Much of the concrete in the bridge will be vibrated.

### THE GABEL AULIA DAM.

This dam which is the longest in the Egyptian system is situated in the Sudan some 25 miles south of Khartoum on the White Nile, and has recently been completed. The Blue Nile and the White Nile join at Khartoum. The Blue Nile carries a very large volume of water during the flood period July to September, as compared to the White Nile. The heavy flow of the Blue Nile tends to pond back the White Nile to a distance of 200 miles above their junction. Towards the end of the rainy season the diminution of flow of the Blue Nile releases this ponded up water, causing a surge late in the year. The Gebel Aulia Dam has been constructed with a view to holding back the White Nile, and releasing its waters gradually thus preventing the surge.

The total length of the structure is 4998 metres. It consists of two sections, a masonry dam 1693 metres long, and an embankment with an impervious concrete core wall 3305 metres long. The masonry dam consists of two lengths of solid section, and a length containing 60 sluices and lock in between. The masonry section of the dam is of granite throughout while that of the embankment section is of compacted filling faced with mosaic sandstone pitching. The dam has a continuous roadway on top 4·5 metres wide.

The underlying formation at the site consists of friable sandstone into which a continuous cut-off wall has been tied. The cut-off trench is 1·5 metres wide, and 2 metres deep in the solid rock. Granite rubble masonry set in 2 to 1 cement mortar was used in the trench to form a cut-off wall. The main body of the dam was built of granite rubble masonry set in 3 to 1 cement mortar. The upstream and downstream slopes are faced with semi-dressed hexagonal mosaic granite blocks. The upstream slope has a batter of 1 in 40 while the downstream slope has a batter of 1 in  $1\frac{3}{4}$ .

The sluice section consists of 60 sluices 4·5 metres high by 3 metres wide, fitted with rolled steel gates.

The embankment dam consists of a core wall of 6 to 1 mass concrete 3 metres wide carried down to the rock and keyed therein. The upstream slope is 2 to 1 and the downstream slope 3 to 1. The slopes are faced with heavy sandstone mosaic pitching. On the upstream side, large blocks of sandstone are placed, extending from the toe of the embankment up to high water level, to serve as wave breakers.

The length of the reservoir created by the dam will be 300 kilometres with a maximum width of 7 Km. The usable capacity is estimated to be 3,500,000,000 cubic metres.

#### THE ALLINGTON SLUICES.

These sluices are situated at the junction of the tidal and non-tidal reaches of the river Medway and were constructed as part of a comprehensive scheme for flood alleviation in the Medway Valley. The new gates consist of 3 vertically rising roller gates electrically operated. The structure consists of a reinforced concrete floor slab, massive concrete piers and abutments, and a reinforced concrete foot-bridge and superstructure. The floor slab is designed as continuous beam so that the weight is spread uniformly over the whole breadth of the foundations. Other features of the structure are described.

#### FLOOD CONTROL FOR LONDON RESERVOIR.

The Brent Reservoir is situated in the Urban Districts of Hendon, Willesden and Kingsbury and is being utilized for the supply of water to the Grand Union Canal. Escape for flood water was provided by means of an arched masonry weir and two culverts. Under the Reservoirs Safety Provisions Act of 1930, the existing means of disposal of flood water were considered inadequate and additional means of disposal of flood water in the shape of 5 siphons were constructed in the body of the old weir in such a manner as not to interfere with the culverts which would normally discharge the water, the siphons coming into operation in an emergency. The siphons are briefly described, with illustrations.

### CONCRETE AND CONSTRUCTIONAL ENGINEERING.

VOL. XXXII.

No. 6—June 1937.

#### DESIGN OF ARCH ROOFS.

Terrington.

This is the first of two articles on the method of calculating the bending moments, thrusts and shears at any point in reinforced concrete roof arches. Roof arch problems are essentially different from bridge arch problems because roof arch profiles are not generally smooth and regular

curves. A method of direct calculation in the case of some types of roof arches with freely supported and fixed ends is outlined in this article. The method is based on the elastic theory which gives the only satisfactory solution of all arch problems. A number of equations giving bending moments and thrusts, etc., for points on the arch profile for vertical loads, and horizontal or wind loads are derived from first principles. An actual example is worked out illustrating the use of the equations.

#### THE BOULDER DAM.

Extracted from a lecture on the Boulder Dam delivered to the Institution of Civil Engineers by Mr. J. L. Savage, Chief Designing Engineer, Bureau of Reclamation, U. S. A. It deals mainly with interesting points in connection with the preparation and placing of concrete in the dam and diversion tunnels. (See page 60 of Bulletin No. 6).

#### THE IMPACT TEST FOR PILES.

Comments on an article published in the March issue of the journal. (See page 27 of Bulletin No. 6). The writer considers that the author of the original article hardly does justice to the advantages of the present method of impact test and discusses these advantages. He questions the value of driving test piles in determining the bearing capacity of pile groups which varies greatly in different kinds of ground, and considers the procedure to be expensive.

Mr. Pimm, the author of the original article in replying to the above comment says that the method of driving test piles is not expensive because the tests are made by means of a special test pile which is recovered, the same pile being used throughout the job. A site can be completely covered with the special test pile and there can be no difficulty in determining the bearing capacity of pile groups.

#### THE MODULAR RATIO : A NEW METHOD OF DESIGN OMITTING m.

Comments on the above paper published in previous issues of the journal by a number of correspondents.

#### VIBRATING CONCRETE ON SLOPES.

Describes a novel method of vibrating concrete placed in the sloping sides of an aqueduct 5576 yds. long on the channel leading to the Champanbest-aux-Bois Reservoir. The vibrating apparatus consists of a travelling platform fitted with a vibrator composed of a steel plate 6 ft. 6 in. long having a useful width of 18 inches and rounded at the edges and stiffened by angle irons. Welded lugs on this plate receive the blows of the pneumatic vibrators.



This plate is moved up and down the slope by hand winches connected to an axle mounted on rollers travelling along the channel sections which form the inner sides of two ladders on either side of the plate. The ladders form a working platform whose plane is parallel to the slope of the channel side. The ladders are connected at the top and bottom by cross girders which move horizontally on channel rails in the direction of the channel. After vibration is completed on a certain width of the slope the platform moves forward, complete with vibrators, to the next adjacent strip.

#### SOIL LINE METHOD OF RAFT DESIGN.

Baker.

The concluding article of a series on the design of beams and rafts for foundations and basement floors. In this article a comparison is made of results of soil line method with exact elastic support method and it is shown that results from the former are as reliable for all practical purposes as those from the latter. The method is rational and effects large economies which more than justify a little expenditure on experimental work to find safe values of the basic soil constants which are required for this method.

#### A NEW TAMPING MACHINE.

On the construction of the San Gabriel Dam in U. S. A. a power driven tamper weighing about half a ton is being used. The machine consists of a four cycle single cylinder internal combustion engine designed to lift the device bodily by using the energy generated in the explosions. The device is in the shape of a heavily truncated cone to the top of which handlebars and a petrol tank are attached. Dry cell batteries and an ignition coil are carried on the operator's back. Explosions are produced by a push-button contact operated from the right handle bar. The machine leaps upward by 9 inches and moves forward at the same time by the same distance, guided by the operator who manipulates the handlebars. Fifty blows a minute can be delivered to the surface to be compacted. The average performance is about 3000 sq. ft. per hour of operation.

*No. 7—July 1937.*

#### DESIGN OF ARCH ROOFS.

Terrington.

Continued from previous issue. The method of calculating horizontal thrust and tangential shear at any point of an arch section is explained and examples are worked out to illustrate the procedure for various types of support and conditions of loading.

## THE MODULAR RATIO: A NEW METHOD OF DESIGN OMITTING *m*.

Further comments from a number of correspondence on the series of articles on Prof. Saliger's method of calculating reinforced concrete without the use of a modular ratio.

## CEMENT PAINT.

A cement paint is being manufactured in England under the trade name of "Ellicem". It is supplied as a powder which when mixed with water is claimed to adhere firmly to brick, plaster, metal, glass, concrete, etc., without the necessity of roughening the surface. The paint is quick setting and is stated to give a hard weatherproof stone-like finish which continues to harden over a period of months and will not crack due to expansion or contraction.

*No. 8—August 1937.*

## ALVELEY BRIDGE.

Mason.

The fundamental problem in the construction of the bridge described in this article was to overcome the difficulty in bridging a river liable to sudden floods bringing down heavy debris which would make the use of falsework supported in the river bed hazardous. The bridge was erected by cantilevering out consecutive sections from each bank until the gap became small enough to close in one operation. The bridge is on the river Severn and consists of a river span of 150 ft. and two shore spans of 60 ft. There are two parallel girders continuous over three spans and monolithic with the river piers which sustain the greater part of the weight of the bridge. Details of construction operations are described.

## DESIGN OF DOMES.

Terrington.

An article describing in full detail the method of design of a reinforced concrete dome. An example is worked out to illustrate the method.

## STRESSES IN ARCH SECTIONS.

Saunders.

After obtaining the value of moment and normal thrust, the accuracy of calculated stresses in an arch rib depends upon the accuracy with which the proportionate depth to the neutral axis is obtained. Several methods are used including trial and error. A direct graphical method is indicated in this article and an example of its use is given.

## THE MODULAR RATIO—A NEW METHOD OF DESIGN OMITTING *m*.

Kazinczy.  
Guldan.  
Pogany.

Further comments on this paper published in January, February and March 1937 issues of this Journal are given.

## THE ENGINEER.

VOL. CLXIII.

*No. 4245—May 21, 1937.*

## THE GEBEL AULIA DAM.

The Gebel Aulia Dam on the White Nile near Khartoum has recently been completed four months in advance of the scheduled time. It has a total length of 3 miles and a height of 60 ft. and is the longest in the Egyptian Irrigation System. (See also under "Civil Engineering & Public Works Review", August 1937 in this Bulletin).

## MODERN HYDRAULIC TURBINES.

Watson.

Continued from previous issue. Describes some types of control mechanism of modern turbines including governors and relief valves.

*No. 4249—June 18, 1937.*

## CHESTER WATERWORKS IMPROVEMENTS.

Describes a reinforced concrete service reservoir recently built with a capacity of 10 million gallons, and a reinforced concrete water tower with a capacity of 200,000 gallons and having a total height of 102 ft. from ground level.

## AMERICAN ENGINEERING NEWS.

## VIBRATING CONCRETE PAVEMENT.

In road building work, the State Highway Department of Illinois has experimented with the vibratory treatment of concrete, with satisfactory results. On recent work half was done with stone concrete and half with gravel concrete, divided into two classes, one ranging from 2 inches to 1 inch in size and the other from 1 inch down to  $\frac{1}{4}$  inch in size. In gravel concrete, the most workable mixture had 40 per cent. of the coarser and 60 per cent. of the finer aggregate while in stone concrete the proportions were 35 and 65 per cent. High frequency electric vibrators were fitted to the finishing machines and the vibration frequency ranged from 3950 to 4075 impulses per minute. The finished work met all expectations and had greater strength at normal cost.

*No. 4250—June 25, 1937.*

## A NEW ZAMBESI BRIDGE.

This is a suspension bridge to be constructed on the Zambesi at the Chirundu Gorge and will form an important link between Northern and Southern Rhodesia.

**BEACH EROSION.**

The Chief of Engineers, U. S. Army, appointed a board known as "The Board on Sand Movement and Beach Erosion" for the purpose of conducting investigations on the erosion of breaches which has assumed serious proportions of late. The Board has published an interim report which places the information obtained up to the present in a form which can conveniently be referred to by persons interested. The main line of investigations included a study of the sand movement, relation of sand size to shape of foreshore, littoral drift and breach improvement by groynes. The findings and conclusions of the Board with regard to the various investigations conducted are discussed.

VOL. CLXIV.

*No. 4251—July 2, 1937.*

**MOSQUITO CONTROL ENGINEERING.**

Abstracted from a series of articles published in the Engineering News-Record in July 1936. (See pages 52—54 of Bulletin No. 3).

**MISCELLANEA.**

A new rustproof paint has recently been put on the market. It is formulated on a chlorinated rubber base and is known as "rust-eater". When applying the paint it is not necessary to clean off all the rust on a metal but merely to clean off loose scale and grease, and when the paint is applied it reacts on the rust and transforms it into an essential part of the protective coating. It is applied either by brush or spraying and sets in twenty minutes.

*No. 4252—July 9, 1937.*

**THE ROYAL SHOW AT WOLVERHAMPTON.**

A motor garden cultivator, a motor plough, and a grass drying plant are described. These were exhibited at the Royal Show at Wolverhampton held from 6th to 10th July 1937.

**THE INLAND WATER SURVEY OF GREAT BRITAIN.**

Hetherington.

(See also under "Water & Water Engineering", July 1937 in this Bulletin).

*No. 4253—July 16, 1937.*

**THE ROYAL SHOW AT WOLVERHAMPTON.**

Describes a mobile grass drying plant and a number of other grass drying plants, a grass cutting and loading machine, a weed cutter and a rapid trench digger exhibited at the show.

## ENGINEERING NOTES FROM CHINA.

## NEW IRRIGATION METHODS IN CHINA.

An enormous area in China is devoted to the cultivation of rice.

For thousands of years the rice fields were irrigated by lifting water by man power from rivers and canals on to the fields. In recent years a large number of small boats have been equipped with portable oil engine pumps in Central China. Owing to poverty of the rice farmers, the Chinese agents of the Oil Companies purchase the machinery and guarantee to the farmers satisfactory irrigation at an agreed annual rate per acre irrigated.

## THE REINFORCED CONCRETE ASSOCIATION.

The Chairman of the Association reviewed the work of the Association in 1936 at its recent annual general meeting. The Chairman's address is briefly outlined in this article. In describing the Association's research work it is stated that work on redistribution of moments in reinforced concrete beams and frames was completed. An investigation into the cause and prevention of cracking is in progress and the results obtained so far have been published. The effect of the grading of aggregate on the strength and workability of concrete has been studied.

*No. 4254—July 23, 1937.*

## MISCELLANEA.

## A NEW BUILDING MATERIAL.

A new building material which is said to have high insulating and acoustical values and at the same time to be fireproof, moistureproof, verminproof and impervious to decay has recently been put on the market in the U. S. A. The name of the material is 'mikolite' and it is produced by heating a micacious mineral ore at 2000°F for 15 seconds. It is claimed that it is the only known micacious material capable of withstanding mixing action without breaking down, and having an affinity for binders such as cement gypsum, etc.

## THE DEVELOPMENT OF IRRIGATION IN INDIA.

A review of the statistical report on Irrigation in India for the year 1934-35 published by the Department of Industries and Labour of the Government of India. The area irrigated from Government works amounted to 29,880,000 acres which is nearly one-seventh of the whole area under crops in British India. The gross revenue from water rates was Rs. 1,234 lakhs and the working expenses Rs. 492 lakhs showing a net return of 4.9 per cent. on the Capital Expenditure. The estimated value of the irrigated crops is

Rs. 9,111 lakhs. The two largest projects recently completed but not yet fully developed are the Lloyd Barrage Project and the Mettur Dam. Other major schemes which are under consideration are the Tungabhadra Project in the Madras Presidency, The Haveli Project in the Punjab, the Grand Trunk Canal in Bengal, and the Gumal River Scheme in the North West Frontier Province.

The formation of the Central Board of Irrigation and the Research Committee of the Board is described and some of the problems before the Research Committee are mentioned. These include waterlogging, canal lining, and use of models in connection with investigations of the meandering of rivers.

*No. 4255—July 30, 1937.*

#### RIVER NENE IMPROVEMENT WORKS.

Works are now being carried out to improve the river Nene which flows into the Wash. Much of the projected work consists of dredging, bank protection by piling, and construction of a number of locks and sluices. These works are briefly described. A portion of the river is being canalised and forty-four locks are being constructed in this reach.

#### A NEW DEEP WATER SUPPLY FOR CROYDON.

A deep well is being constructed for the water supply of the Borough of Croydon. A special method of well boring is being used, and a 17 inch test hole has been drilled to a depth of over 1,100 ft. in less than 300 working hours. A feature of the system is the use of a continuous stream of liquid clay which is pumped down through the hollow rods of the rotating drill. It emerges through orifices in the bit and then rises up the borehole, overflowing into a settling tank at the top whence it is drawn into the pump again. This circulation of liquid clay provides a means of washing out the debris from the drill and carrying it in suspension into the settling Tank.

If the stratum is porous, some of the clay is absorbed and this fact is indicated by a drop in the level of the clay which returns in the settling tank. When the test boring has been completed to a depth exceeding that to which it is intended to drive the well, work is suspended, leaving the clay to settle in the hole. As it settles, it dries and provides an impermeable coating right down the tube. The well is mechanically reinforced against caving in and all natural water flow from permeable strata is sealed off.

The various stages of the well sinking operation are described and explained with the help of sectional diagrams. A high pressure pump is used for the circulation of the

liquid clay. After placing the steel casing tube in position, a liquid mixture of pure cement and water is circulated by the same high pressure pump and a permanent cement seal about an inch thick is formed round the casing.

No. 4256—August 6, 1937.

#### STANDING WAVE PROBLEMS, No. I.

Blench.

This series of articles refer to the two problems (a) determination of the position of the standing wave on a gently sloping weir glacis and (b) design of a fall so that the standing wave shall not move off the glacis on to the channel bed. In this article, which is the first of a series of three, the graphical representation of Bernouilli's equation and the hydraulic jump equation, are discussed. The energy of flow at a section is defined, and the procedure of obtaining energy of flow diagrams is described. The method of drawing the water profile for a flume which both contracts and depresses, in a channel with given conditions of flow is explained. The flow through such a flume is analyzed and a number of energy relations are developed, and their practical significance is interpreted. In commenting on the practical aspects of the flume problem the author considers that the depressed bed flume should have a future. Constricting channels in bridges is generally avoided on the grounds of afflux and jetting but the author's analysis of flume flow makes it clear that greater constriction is possible without fear of afflux if the cross section is made up by depressing the floor. The presence of a rising floor helps to spread the jet. As a satisfactory example of a flume the author mentions a flume for 250 cusecs, with normal width of 25 ft. flumed to 5 ft., a throat length of 10 ft., and a depression of floor of 3.6 ft. The design of long crested weirs is briefly discussed.

The author then explains the graphical representation of the hydraulic jump equation. The energy of flow diagrams and impulse plus momentum diagrams for a hydraulic jump are depicted, and the principle underlying the finding of the position of the standing wave is explained.

#### ALLINGTON TIDAL SLUICES.

These sluices were constructed as part of a scheme for flood alleviation in the Medway Valley. These are described in this article. (See also under "Civil Engineering and Public Works Review", August 1937 in this Bulletin).

No. 4257—August 13, 1937.

#### STANDING WAVE PROBLEMS No. II.

Blench.

This is the second article of the series and discusses some standing wave problems and their solutions. Some of the problems treated are : wave on the downstream floor with clear

trough and trough full of water ; and wave on gently sloping glacis with trough empty and full. In the course of the theoretical discussion of the problems a number of mathematical relations are developed and practical comments are offered for each problem in which the practical significance of the relations derived as affecting design of actual works is explained.

#### **DRUM WEIR WITH SEPARATELY DRIVEN WING.**

Describes a weir erected at Guttenbach, Germany, which consists of 3 bays of 30 metres each, in each of which there is a steel drum. At each end, the drum carries a pinion engaging with a rack fixed in the pier, and at one end a chain is wound round the drum and attached to it, whilst its other end is wound on to a winch. The arrangement is such that by the operation of the winch the drum is caused to rotate and so under the action of the pinions, climbs up the racks, freeing the opening for the discharge of flood waters. The drum weir is particularly suitable for use in rivers which carry a considerable amount of drifting matter or where winter conditions are so severe that ice is likely to be formed.

*No. 4258—August 20, 1937.*

#### **STANDING WAVE PROBLEMS. NO. III.**

Blench.

This is the final article of the series and in the words of the author "the object of this section is to derive rigidly the equations of motion of jump with empty and full troughs on a flat floor ; estimate the error likely to occur through neglecting vertical acceleration ; suggest a theory of curvatures for jump from the bottom of a steep glacis and indicate the problem which requires to be solved for the jump on a glacis".

#### **THE GERMAN MOTOR ROADS.**

A network of arterial roads for exclusive motor traffic is being constructed in Germany and is called the "Autobahn" network. The roads are being built to three standards depending on the country through which the road passes. The three standards are suitable for speeds up to 110 miles an hour. The standards are based on theoretical considerations of the requirements of a vehicle moving at high speed, modified to some extent by practical knowledge. As a result of theoretical investigations curves have been prepared showing the sighting distance, speed and vertical curvature relationships, and the speed radius of curvature and superelevation relationships. These curves have been reproduced. The maximum gradient, radius



of horizontal curves, and minimum radius of vertical curves for the three types of road are given in a table. The roads are being constructed of concrete. Joints of various kinds have been used and research work is in progress to determine the most satisfactory type of joint. The road consists of two one-way carriage ways 7.5 metres wide, separated by a green strip 3.5 to 5 metres wide.

*No. 4259—August 27, 1937.*

#### THE GERMAN MOTOR ROADS.

Continued from previous issue. Contains a general description of types of road junctions, road bridges and other adjuncts being used in the construction of the "Autobahn" system in Germany. The article concludes with a plea for the launching of a similar roadbuilding scheme in England.

*No. 4260—September 3, 1937.*

#### MISCELLANEA.

##### CEYLON HYDRO-ELECTRIC SCHEME.

A new hydro-electric scheme will soon be commenced in Ceylon. It will supplement the existing supply system of Colombo. It entails the construction of a dam 345 ft. long and 94 ft. high. The water impounded will be conveyed through a tunnel 7863 ft. long to a surge chamber whence it will be conducted through pipe lines to the power station 1,500 ft. below. The power station will house three pelton wheel type water turbines coupled to alternators, the total capacity of the plant being 25,000 k. w.

##### AIR CONDITIONING IN A HONG KONG BANK.

Smith.

This article gives details of their conditioning plant installed at the Hong Kong and Shanghai Bank Building in Hong Kong about a year ago. The plant has to deal with 2,300,000 cu. ft. of enclosed air, and is the largest in the tropics. The building covers a floor space of 56,000 sq. ft. and is 247 ft. high with thirteen floors above ground level, and a basement. The whole of the air in this huge building is conditioned and there is constant but unobtrusive ventilation. In the nine summer months from April to December the air is cooled; in winter, the conditioned air is heated before it is introduced into the rooms and the temperature is maintained by hot water heating panels hidden in the ceilings of the rooms. The plant consists essentially of an air washer to cool and purify the air, a circulating fan to distribute the air to the various inlets to

rooms, air ducts for supply and exhaust air, and refrigerating plant for the air washer. Detailed description of the installation is given and the local working conditions are discussed. The cost of the installation was £100,000.

*No. 4261—September 10, 1937.*

#### **AIR CONDITIONING IN A HONG KONG BANK.**

Middleton Smith.

Continued from previous issue. The working of the air conditioning plant at the bank is described and its effects in general is discussed. The principal advantages mentioned are the saving of fans, cleaning, absence of dust, less depreciation of furniture and increase in human efficiency.

#### **THE BRITISH ASSOCIATION No. I.**

The British Association for the Advancement of Science met at Nottingham in September 1937. Section G concerns engineering and the proceedings of this section include a lecture on the Trent Catchment Board in which the programme of improvement of the catchment area of the river Trent is briefly outlined. The scheme comprises tidal bank works, regrading and resectioning of the river in several reaches, construction of flood relief channels and sluicing of solid weirs.

#### **THE GEOGRAPHICAL JOURNAL.**

VOL. LXXXIX.

*No. 5—May 1937.*

#### **THE TENNESSEE VALLEY PROJECT.**

Barbour.

The main features of the Tennessee Valley Project now under construction in the U. S. A. are described in this article. The project plans to utilize and regulate the water resources for navigation and power, to introduce cheap electricity for use in homes and farms, to develop the mineral resources of the area, to check erosion by soil conservation measures and to provide flood control. Some of the more important objectives of the scheme and the means of attaining them are discussed. The scheme involves the construction of a number of dams along the river to provide storage and improve navigation. The dams are being constructed serially. Steps taken to combat erosion are described. An abandoned nitrate factory is being utilized to manufacture artificial fertilizers for the improvement of land. (See also pages 79 to 85 of Bulletin No. 5).

## THE TRANSPORT OF SAND BY WIND.

Bagnold.

In this article the author gives an account of recent experimental work carried out by him on the process by which sand is moved by a wind over surfaces of sand and pebbles. According to the author the subject is a special case of the general problem of the transport of solid particles by fluids. He describes in general the behaviour of sand grains under the action of wind and compares an actual photograph of the motion of sand particles with some calculated theoretical paths. He then goes on to describe his experiments which were carried out in a specially constructed wind tunnel and gives a detailed treatment of the problems investigated and results obtained. An explanation for the phenomenon of dune growth is offered, and a formula giving the mass displacement of sand in terms of the wind gradient has been arrived at. A method is given whereby the annual sand movement over a large tract of country may be computed from existing meteorological records.

## HEATING & VENTILATING ENGINEER.

VOL. IX.

No. 108—June 1936.

### AIR CONDITIONING BY REFRIGERATION AND OTHER METHODS.

Henly.

Continuation of an article from a previous issue on the use of refrigeration and other methods of air conditioning.

### PIPE SIZING FORMULÆ—ALLOWANCE FOR VISCOSITY AND VELOCITY FACTORS.

Clementson.

In the May issue of this journal there appeared an article entitled "Temperature, Viscosity and their influence upon the flow of water in pipes". The present article is based on the conclusions drawn therein; the writer shows that the values arrived at can be reconciled to well-known pipe friction formulæ.

## JOURNAL OF THE INSTITUTION OF CIVIL ENGINEERS.

No. 7—June 1937.

THE RECONSTRUCTION OF THE CHESTER—HOLY-  
HEAD ROAD NEAR PENMAENMAWR, NORTH WALES.

Humphreys.

The old road proved unsuitable for modern traffic and a new alignment was decided upon. The features of this new road are described in this article. The road runs along a mountain side in part of its length and passes through a tunnel in the rock 565 ft. long. Other works of importance are a reinforced concrete slab viaduct and a bridge of reinforced concrete consisting of seven fixed arch spans of 80 ft. The arches are five centred. Details are given of side hill cuttings, retaining walls, the tunnel, the viaduct and the bridge; foundation conditions and operations are described.

## THE FLOW OF THE RIVER SEVERN, 1921-36.

Dixon.

Fitzgibbon.

Hogan.

This paper gives data of river-flow investigations of the river Severn. It deals with methods of discharge measurements, selection of gauge sites, relationship between gauges and discharges, calculation of daily discharges, hydrographs of river-flow, rainfall, and run-off. In an appendix results are discussed of the surface float method of measuring discharges for which observations were carried out simultaneously with current meter discharge observations. Current metres were however generally used.

## THE BOULDER DAM.

Savage.

A lecture on the Boulder Dam delivered before the Institution of Civil Engineers by the Chief Engineering Designer, Bureau of Reclamation. (See page 60 of Bulletin No. 6).

THE ESTIMATION OF RUN-OFF AREAS SUBJECTED TO  
RAINSTORMS.

Daymond.

An abstract of the original paper is given herein. The paper contains a brief general discussion on existing theory of the relationship between rainfall and run-off which is based on Kuichling's law first enunciated in a paper published

in the Transactions of the American Society of Civil Engineers, 1889. Subsequently, a rational formula for run-off was evolved by another author based on Kuichling's law. The present author discusses the justification for and the limitations of this formula which does not account for certain factors such as the shape of the area, slope of ground, etc. He then proposes a new general theory which does not suffer from the limitations of the old one and leads to greater exactitude in the estimation of flow. The general type of equation derived by the author is discussed and the methods of solution are indicated. Examples are given to show the effect of the shape of area and of intensity of rainfall curve upon the run-off, and the assumptions made in the development of the general theory are considered together with the values of run-off resulting from such assumptions.

## THE ROYAL ENGINEERS JOURNAL.

VOL. LI.

*September 1937.*

### QUETTA RECONSTRUCTION.

King.

This article gives a general outline of the progress of the work of permanent reconstruction at Quetta.

### FORESTRY.

Molesworth.

A general article on the theory and practice of forestry dealing with the processes at work in a mature tree, the various phases in the growth of a tree and the planting and care of trees.

## WATER AND WATER ENGINEERING.

VOL. XXXIX.

*No. 476—March 10, 1937.*

(Manufacturers' Annual Review Number).

There is nothing of interest in this to irrigation engineers.

*No. 480.*

Not yet received.

*No. 481—July 1937.*

### THE INLAND WATER SURVEY OF GREAT BRITAIN.

Hetherington.

A paper presented before the British Waterworks Association.

Great Britain has recently awakened to the need of a comprehensive survey of its water resources as is evidenced by the appointment of the Inland Water Survey Committee, the object of which is to advise on the Inland Water Survey for Great Britain, on the progress of the measures undertaken, and on further measures required. In previous years any water survey work undertaken has been limited to the needs of the agency conducting such survey. The enormous growth in population and industrial activity has made it imperative to initiate a water survey in order to prepare a reliable inventory of the water resources of the country which will serve as a guide in future water undertakings. The information needed relates to rainfall, surface water, and ground water. The procedure of survey as recommended by the Committee is discussed. Other features of the survey such as direction and control, interpretation of results, inspectional arrangements, financial considerations, and character of the results of the survey are briefly reviewed.

#### **BELLMOUTHED WEIRS AND TUNNEL OUTLETS FOR THE DISPOSAL OF FLOOD WATER.**

Discussion by several members on the above paper by Mr. W. J. E. Binnie presented to the summer meeting of the Institution of Water Engineers, and Mr. Binnie's reply to the discussion.

*No. 482—August 1937.*

#### **EDITORIAL NOTES.**

##### **BENTONITE AS A COAGULANT.**

The coagulating value of bentonite has been investigated by two American University Professors of Chemistry. Dispersed in turbid waters containing mineral matter, the sodium bentonites can be used effectively for coagulation in treatment of waters having a definite minimum concentration of dissolved electrolytes. In the case of waters carrying calcium salts they have a softening effect also.

*No. 483—September 1937.*

##### **STOCKPORT WATER SUPPLY.**

A new scheme for the supply of water to the town of Stockport is under construction. The complete scheme comprises two impounding reservoirs, catchwaters, filtration plants, two service reservoirs, aqueducts, trunk mains, etc. One

of the reservoirs, the Fernilee reservoir, has recently been completed. It covers an area of 86 acres and is formed by an earthen dam with a puddle core, 650 ft. long, and 132 ft. high. The puddle core section is founded on the concrete which lies in the central cut-off trench and which goes to a depth of 232 ft. below ground level. Details of all the works comprising the first instalment of the scheme which has been completed are given.

#### WATER LEVEL, FLOW GAUGING AND METEOROLOGICAL STATIONS. PART II.

McClean.

The first part of this paper was published in June 1937. This article deals with flow and storage measurements and their scope and application, and the graphical representation of the records of water level flow and storage. Application of the records to the solution of various problems are explained.

The procedure of flow gauging and the preparation of tabular and diagrammatic records from the observed data are explained in detail. Some of the problems for the solution of which the records can be applied are: the assessment of water resources, the preparation of hydrographs of river flow, water power problems, water supply problems and storage problems.

#### THE DAYMOND THEORY OF STORMWATER RUN-OFF APPLIED TO RESERVOIRED CATCHMENT AREAS.

Lloyd.

Until recently the theory of relationship between intensive rainfall and stormwater run-off has been based on Kuichling's law. Recently the scope of Kuichling's rational formulæ has been enlarged and a general theory has been proposed by Daymond. The object of this article is to indicate how the Daymond theory may be extended to include a condition occurring on a catchment of moderate area which may be capable of being reservoirised.

#### FOREIGN AND COLONIAL.

##### THE WATER SUPPLY OF QUETTA.

Describes briefly the Spin Karez project for the water supply of Quetta (See page 13 of Bulletin No. 3).

*Special Supplement to September 1937 issue.*

This supplement is entitled "Large Dams" and contains a few papers and summaries of others presented at the Second Congress on Large Dams held in U. S. A. in September 1936. The papers are as below.

## DAMS BUILT OF PRECAST CONCRETE BLOCKS.

Halcrow.

This article suggests the use of precast concrete blocks instead of mass concrete in the construction of large dams. The chief advantage claimed is that all shrinkage due to cooling of the concrete while setting takes place before the concrete blocks are placed in the dam. Cracks which are common in mass concrete dams will thereby be eliminated, and the prevention of vertical shrinkage during setting would facilitate the fitting of cast iron guides to the face of the dam for control sluices. Up to the present time precast concrete blocks have been used with successful results in building temporary cofferdams but there is no reason why concrete blocks should not be used for a large permanent dam

## CONTRACTION JOINTS.

Sandeman.

The author suggests that joints in masonry dams should be referred to as "contraction joints" and not as "expansion joints" since they are designed to deal with contraction. It is unnecessary to provide for expansion as this simply compresses the masonry. He quotes a few examples of dams showing numerous cracks such as the Boonton Dam in U. S. A. and the Assouan Dam in Egypt. Some well known English dams however such as the Vyrnwy Dam and the Derwent dam have not developed cracks and the author suggests a method of construction to avoid cracks, based on experience with the English dams. His principal recommendations are :

- (a) moderate speed in building ;
- (b) the use of as large proportion of stone as is possible in comparison to concrete.
- (c) the use of less finely ground cement and the use of cement made to a specification limiting the rise of temperature in setting ;
- (d) aeration of cement before using ;
- (e) the use of as stiff a mix as possible without detriment to the workability.

He recommends a length of 25 to 30 ft. between joints. As regards joints, the type used recently in a dam in Londonderry where the face of one section is designed with a large projecting panel bevelled on all four sides which fits into a corresponding depression in the adjoining section is suggested as one of the simplest and most effective.



## ALLUVIAL DEPOSITS IN RESERVOIRS, THEIR IMPORTANCE AND THE MEANS TO LESSEN OF PREVENT THEM.

Visentini.

"This report is a compendium of what is positively known up to date in Italy about alluvial deposits in reservoirs and the transport of solid material in the watercourses. It is only a collection of factual data and experimental findings without theories and laboratory researches on the question".

In discussing the most efficient remedies against the "solid snare" in reservoirs, the author classifies the Italian river valleys into three types depending on their geological formation and suggests measures to prevent erosion and the consequent transportation of solid matter into the reservoirs for each type of valley.

## GROUTING OF MASONRY DAMS.

Derqui.

This article deals with the problem of waterproofing the main bodies of high masonry gravity dams in which there is percolation through the dam proper. Foundation seepage or leakages round abutments are not considered. The waterproofing operations consist of drilling a number of holes in the body of the dam and injecting grout under pressure into them. Location of holes, pressure to be used in injecting grout and similar questions of practical interest are discussed.

## GEOLOGY OF RESERVOIR-DAM SITES.

Bromehead.

Discusses important features of strata of solid rock and drift deposits as affecting dams and reservoirs. The importance of a knowledge of local geology in fixing sites for dams and reservoirs is clearly brought out. Instances are mentioned of the useful assistance of the Geological Survey of Great Britain in fixing sites of dams.

## SPECIAL CEMENT FOR LARGE DAMS.

Summaries of the following papers are given :—

1. Temperature effects in mass concrete—Davey. (See page 15 of Bulletin No. 5).
2. Special cement—Halcrow.

Data are given of temperature rise and crack formation of Laggan Dam. Methods and means of testing heat evolution and solubility of cements are described.

## DESIGN AND WATERPROOFING OF SHRINKAGE, CONTRACTION AND EXPANSION JOINTS.

Summaries of the following papers are given :—

1. Shrinkage, Contraction and Expansion Joints in Norris Dam—Jones.
2. Keying Scheme for Arch Dams—Coyne (France)
3. Design and waterproofing of shrinkage, contraction and expansion joints in large dams —Link (Germany).
4. Construction Joints—Juillard (Switzerland).
5. Joints in Concrete Dams—Williamson (Great Britain).
6. Joints in Gravity Dams—Renaud (France).
7. Shrinkage, Contraction and Expansion Joints—Thimel (France).
8. Waterproofing of Expansion Joints with Rubber in Concrete Lining of a Supply Canal—Smrcek & Kalla (Czechoslovakia).

Summaries of the above papers have also appeared in other periodicals. See pages 20, 21, 50 and 146 of Bulletin No. 5.

## STUDY OF THE FACING OF MASONRY AND CONCRETE DAMS.

Summaries of the following papers are given :—

1. Watertightness of the Body and of the Facing of Concrete Dams—Weigl (Austria).
2. Metal Facing of Masonry and Concrete Dams—Iwanow (Bulgaria).
3. Facing of Masonry and Concrete Dams.—Bolomey (Switzerland).
4. The Facing of Masonry and Concrete Dams—Lossmann and Petzny (Czechoslovakia).
5. Study of the Facing of Masonry and Concrete Dams—Binnie (Great Britain).
6. Use of Bituminous Materials in the Construction of High Dams—Glebov (U. S. S. R.)
7. Design and Behaviour of the Facing of Large Dams in Germany—Ludin (Germany).

Summaries of the above papers have also appeared in other publications, (See pages 21, 22 and 146 of Bulletin No. 5).

## GEOLOGICAL AND GEOTECHNICAL STUDIES OF DAM SITES.

Summaries of the following papers are given :—

1. Determination of Depth of Bedrock—Sundberg (Sweden).
2. Geotechnical Studies of the Foundation Materials of Large Dams—Grischin (U. S. S. R.).
3. Geotechnical Studies of the Foundation Materials of Large Dams—Lugeon (Switzerland). (See pages 23 and 147 of Bulletin No. 5).

## CALCULATION OF THE STABILITY OF EARTH DAMS.

Summaries of the following papers are given :—

1. Seismic Stability of the Earth Dam—Mononobe, Takata and Matumura (Japan).
2. Rolling the Soil in Earth Dams—Myslivec (Czechoslovakia).
3. Stability of Earth Dams in Cases of Reservoir Discharge—Mayer (France).
4. Problems Concerning Stability Calculation of Earth Dams on Movement and Action of Infiltration Water—Takata and Kambara (Japan).
5. Stability of Embankment Foundations—Gilboy (U. S. A.)
6. Stability of Earth Dams—Pagliaro (Italy). (See pages 23, 24, 147 and 148 of Bulletin No. 5).

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## SCHWEIZERISCHE BAUZEITUNG.

(In German.)

VOL. 113.

No. 13—March 31, 1934.

## RECENT EXPERIMENTS ON SHINGLE MOVEMENT.

Meyer-Peter.

Favre.

Einstein.

Describes the results of experiments conducted at the Hydraulic Research Institute of E. T. H. on the movement of shingle of uniform size. Examines Schoklitsch formula, which sets forth that shingle movement is proportional  $q-q_0$  where  $q$  is the actually measured discharge and  $q_0$

the discharge that will correspond to the condition of equilibrium with the same slope but no shingle; and gives

$$\text{the authors' own formula} \quad \frac{q^{\frac{2}{3}} J}{d} = 17 + \frac{0.4Z^{\frac{2}{3}}}{d}$$

where  $q$  is the discharge in Kg/Sec. m.,  $z$  the shingle movement in Kg./sec. m.,  $d$  the average diameter of the shingles and  $J$  the relative slope of the energy line. Compares both the formulas and gives reasons for justification of the authors' formula.

(Translation of the article is also available).

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## VIZUGYI KOZLEMENYEK.

(In Magyar but containing English summaries).

VOL. XVIII.

No. 4—October-December 1936.

### THE VEGETATION OF ALKALI LANDS IN HUNGARY.

Fay.

The object of this article is to familiarize civil engineers working on reclaiming alkali soils with plants which give useful indications of the degree of alkalinity. The plants which are suitable for the afforestation of alkali lands are described and their characteristics are discussed.

### A SHORT SUMMARY OF THE SCIENCE OF SOIL.

Endredy.

A comprehensive article on the science of soil covering general properties of soils and their examination. The composition of soil is described. Physical properties of soils such as coherence, shrinkage, plasticity are discussed. The behaviour of soil towards water is discussed. The second part of the article deals with the procedure of examining soils and interpretation of results of examination.

### RECENT FEATURES OF CONCRETE MANUFACTURE.

Schwertner.

In this article are discussed the strength of concrete as influenced by the water cement ratio, the influence of temperature on the setting of concrete, natural cements as complementary materials, and vibration of concrete.

## REVUE GENERALE DE L'HYDRAULIQUE.

(In French).

*No. 15—May-June 1937.*

## FLUVIAL HYDRODYNAMICS—VARIABLE REGIMEN.

Cagniard.

In this article the author develops an application of Carson's method of integration to the study of the propagation of intumescences of low amplitude, downstream or upstream of a large river of which the initial regimen is permanent and uniform. This problem has previously been resolved by M. Deymie and discussed thoroughly by M. Masse. Nevertheless the exposition contained in this article offers a simplification of the discussion and further development of some points.

THE CATASTROPHIC FLOODS OF MARCH 1936 AND  
JANUARY-FEBRUARY 1937 IN THE UNITED STATES  
OF AMERICA.

Parde.

A concluding article by M. Parde, in which he traces the path of the floods from rainfall and describes the methods of gauging.

## PEDOLOGY.

(In Russian)

*No. 1—1936.*

## SHEARING STRENGTH OF SOILS.

Figulevsky.

This article contains an English summary.

It gives an account of the experimental analysis of the shear process by means of a device developed by the author with the results obtained. The author has suggested a new formula for shear in loose and cohesive materials which he believes to be more accurate than other existing ones. His investigations contradict the statement of Terzaghi to the effect that the coefficient of friction of soil complexes increases with the decrease of normal load on the surface of shear.

# STATISTICAL THEORY OF SOIL STRUCTURES.

Pikrovsky.

This article also contains an English summary. A statistical method for a quantitative description of the various structural types of soil which is being worked out by the author is described.

# ULTRA POROSITY OF SOILS.

Dumansky.

Chapek.

This article also contains an English summary. Determination of ultraporosity of soils by the absorption of benzol vapours is described.

# THE METHOD OF DETERMINING THE MAXIMUM HYGROSCOPIC WATER CONTENT IN SOIL.

Nicolaiev.

This also contains an English summary. A method for determining the maximum hygroscopic water content in soils by means of a saturated solution of potassium sulphate is described.

# THE EVOLUTION OF THE CARBIDE METHOD FOR DETERMINATION OF SOIL MOISTURE.

Vadiunina.

This also contains an English summary. The short-comings of the carbide method of determining soil moisture are discussed.

# THE INFLUENCE OF THE FORM AND SIZE OF IRRIGATED SQUARES ON THE PERMEABILITY OF THE SOIL.

Katchinsky.

This contains a German summary which is being translated.

# AGRICULTURE AND LIVE-STOCK IN INDIA.

VOL. VII.

*Part IV—July 1937.*

# ERADICATION OF CYNODON DACTYLON (HARIALIDOU GRASS) BY TRACTOR PLOUGHING IN THE BOMBAY- KARNATAK.

Salimath.  
Kulkarni.  
Gayatonde.

This plant is a common grass much in favour as a horse feed and for lawns. In the field however it is a persistent and

troublesome weed. Certain investigations were conducted in fields infested with this weed as regards the extent of its infestation, depth of runners and the effect of deep ploughing on the weed. The results are presented in this article and certain conclusions of practical value are drawn from the investigations.

**'PAN-SUKH' DISEASE OF RICE IN THE CENTRAL PROVINCES.**

Dastur.

Describes a condition of rice known as "Pan-Sukh" disease in the Central Provinces. It is a physiological disease.

*Part V—September 1937.*

**THE FOOT-HILLS GRAZING PROBLEM IN INDIA.**

Gorrie.

This article describes grazing conditions in the drier parts of Northern India comprising Punjab, North-West Frontier Province, Sind, the United Provinces and Central Provinces. In areas where the rainfall is not heavy grassland can only exist under reasonable treatment and if once destroyed cannot reinstate itself as easily as it can under a slightly heavier rainfall. Over very large tracts of the country grasslands have disappeared, and the last vestiges of shrub growth form the ordinary daily ration of the village herd. The result is heavy erosion in the foothills and a tremendous increase of run-off. The effect is only beginning to be realized in the recurring failure of the Punjab Canal systems to produce sufficient water for cold weather irrigation.

The author suggests a line of attack in dealing with overgrazing and other misuse of land which he describes in detail. His main idea is to develop fodder resources for local live stock and to improve the standard of cultivation in any way which will tend to conserve soil and reduce run-off. He also suggests reduction of surplus animals by a propaganda for fewer and better cattle.

**THE QUALITY OF SUGARCANE IN NORTHERN INDIA  
IN RELATION TO BORER INFESTATION AND DISEASE INFECTION.**

Haldane.

During February 1937 a survey was made over the supplies of cane delivered to ten factories in United Provinces and North Bihar. The examination of the cane was made at the factories and every effort was made to make the survey representative of the areas of supply and the materials delivered. These investigations are described and the results for each factory are given. Conclusions arrived at as the result of the survey are detailed.

**FURTHER WORK ON THE MANURING OF SUGARCANE  
IN NORTH BIHAR.**

Cliff.

Presents results of manurial trials on cane on the farms under the author's control indicating the value of a small dressing of superphosphate in conjunction with both farmyard manure and green manuring.

**THE INDIAN JOURNAL OF AGRICULTURAL SCIENCE.**

**VOL. VII.**

*Part III—June 1937.*

**STUDIES IN *IUSARIUM* WILT OF SANN-HEMP.**

Uppal.  
Kulkarni.

A destructive wilt disease has caused heavy reduction in the yield of Sann-hemp which is used as green manure in Bombay Deccan. This article gives a short account of the symptoms of the disease and the organism which causes it.

*Part IV—August 1937.*

**STUDIES ON THE ROOT-ROT DISEASE OF COTTON IN  
THE PUNJAB.**

Vasudeva.

Discusses the effect of the following factors in influencing the incidence of the disease: irrigation, soil moisture, date of sowing, and sowing in ridged and flat rows. Certain experiments were carried out which are described with their results.

**AIR SURVEY.**

(Published by Indian Air Survey and Transport, Ltd., Dum-Dum).

This publication has been designed with the object of explaining and illustrating Air Survey methods. In recent years tremendous advances have been made in the technique of air survey. Air survey methods can guarantee accuracies up to 1 in 300 between points fixed on the ground. Scales from 1 inch to 12 inches to the mile can be prepared by graphical methods and larger scales can be prepared by particular use of the stereoscope. An important difference between a photograph and a map is that the photograph records everything seen by the eye of the camera while a map contains only those features which the surveyor considers of importance. Invaluable topographical information can be furnished by a photograph regarding forestry, the state of crops, extent of floods, archæological and geological indications, and river maps.



Some ground control methods in air survey and the use of the stereoscope are described. A few photographs as examples of air survey work are given and include an anaglyph of a part of Darbhanga (Bihar) after the earthquake of 1935, a town map, photograph of a paddy tract in Bengal, and photograph of a river channel.

## CURRENT SCIENCE.

VOL. VI.

No. 1—July 1937.

### SOIL FERTILITY AND THE ROLE OF TRACE ELEMENTS.

Rao.

Recent investigations on soil fertility and the factors that influence plant growth have shown that some elements in the soil, needed only in very small quantities exercise marked influence on plant growth. Amongst these are manganese, bismuth, zinc, etc. These elements are sometimes present in such small quantities that ordinary laboratory methods may fail to detect their presence. Valuable information may be obtained by spectrographic examination of soils as it enables detection of all metallic elements contained in them without the chance of the rarest ones going undetected. Further experiments with this method are in progress.

### IMPORTANT INSECT PESTS OF SUGARCANE IN THE BOMBAY PRESIDENCY.

Deshpande.

This article gives all the available information about the major insect pests of sugarcane in Bombay Presidency and the control measures which have been tried and found useful.

### AGRICULTURAL RESEARCH IN CHINA.

Datta.

Describes agricultural research work being carried out in China at the present time. The researches are directed to crop improvement in regard to wheat, rice, cotton and potatoes. An important investigation with rice concerns the effect of the length of exposure to daylight on different varieties of rice. A shortening-day treatment will make the early, medium, and late varieties flower at the same time. Other investigation include farmyard manure and fertilizer tests, forestry research, and silkworm research.

No. 2—August 1937.

### SCIENCE NOTES.

A 25 square mile tract can be "picked up" from an airplane and set down on a table top in three dimensions by means of an instrument known as a multiplex projector now being built for the U. S. Army Corps. An airplane working in conjunction with the aero-projector flies over the area,

and an automatic camera takes a film of the area. The film is developed and printed on glass plates which are used as lantern slides for a battery of projectors. The images formed by adjacent projectors on the table overlap just as the areas covered in successive photographs do. Alternate projectors form their images in red and green light. The user wearing spectacles with one lens red and the other green sees the overlapped area stereoscopically.

*No. 3—September 1937.*

Nothing of interest to irrigation engineers in this issue.

### GLEANINGS FROM HERE AND THERE.

(Issued by the Associated Cement Companies, Ltd., Bombay.)

*No. 3.*

There is nothing of interest to irrigation engineers in this.

### INDIAN AND EASTERN ENGINEER.

VOL. LXXXI.

*No. 1—July 1937.*

#### VENTILATION WITH AIR CONDITIONING IN MODERN BUILDINGS.

Dolby.

Defines air conditioning and discusses the basic principles involved. Mechanical means for air conditioning are described and examples of some actual installations are given with illustrations.

#### LONG RANGE EXCAVATING. PART II. THE SLACKLINE CABLEWAY.

Taylor.

The slackline cableway is a feature of a type of scraper used where the excavated material has to be lifted an appreciable height, where it has to be handled over long distances, or where there is a combination of the two conditions. The operation of this type of ensemble is described with reference to the construction of a reservoir and cleaning out rivers. A typical installation is described and illustrated.

#### INFLUENCE OF TEMPERATURE ON THE STRENGTH OF CONCRETE.

Davey.

Gives results of a large number of experiments made at the Building Research Station on the crushing strength of concrete with several types of cement at different temperatures.

*No. 2—August 1937.***REINFORCEMENT PRE-FORMING MACHINES.**

An automatic portable machine for bending reinforcement bars to any desired shape is illustrated.

**PENETRATION OF MOISTURE IN MASONRY WALLS.**

Rates of penetration of moisture through walls of brick masonry are being measured by the U. S. A. National Bureau of Standards to determine what combinations of materials and types of construction are most resistant to leakage when exposed to rainfall. The results of the tests carried out so far indicate that the quality of workmanship and the thickness of the walls have a major influence on the rate of penetration of water.

*No. 3—September 1937.***THE PYKARA HYDRO-ELECTRIC DEVELOPMENT SCHEME****—SECOND STAGE.**

The second stage of this scheme comprises the Mukurti Dam which is now under construction, and will soon be completed. It is an arched masonry dam 520 ft. long with a maximum height of 90 ft. above the river bed. There is a controlled weir section 160 ft. long on the left flank. The dam is built of random rubble masonry in cement mortar with coursed rubble facing. Impervious mortar was used for the upstream face for a thickness of 5 ft. from the top face and 12 ft. from the bottom face. Holes were drilled on the upstream two-thirds of the width of the foundations at 15 ft. apart and were grouted under pressure with a view to seal the rock. Power house plant and other features of the project are described.

**HYDRAULIC FLOW FORMULAE. CORRELATION BY THE  
NEW ENERGY THEORY.**

Blench.

In this article it has been shown that the same form of resistance law and energy dissipation law underlies turbulent flow whatever be the nature of the boundary; and that the various authoritative flow formulæ can all be derived from exactly the same form of resistance law, and are capable of being expressed in one form. The energy theory is outlined and an energy equation true for both pipes and channels is derived. The physical meaning of Mr. Gerald Lacey's  $\frac{V^2}{R}$  is discussed and it is shown that this expression is a measure of the resistance per lb. to eddy motion from boundary to surface.

**WATERPROOF PAPER AS INSULATION BETWEEN SUB-  
SOIL AND CONCRETE.**

The use of waterproof paper for insulating new concrete from the sub-soil in road construction is becoming almost

standard practice in Great Britain. Sub-soil characteristics which call for the employment of a strong waterproof building paper are porosity and contamination. Their effect on concrete is discussed and the advantages of using a waterproof paper as insulation between sub-soil and concrete are explained.

## THE INDIAN CONCRETE JOURNAL.

VOL. XI.

No. 7—July 1937.

### NEWS & NOTES.

#### SPRAYING FIREPROOF CEMENT.

The spraying of paint, distemper, etc., has been common practice for a number of years but now the spraying of cement is coming into use. A particularly useful application is in connection with the refractory lining of certain types of furnaces. To cover the firebrick walls with a smooth lining, a high pressure cement gun sprays the cement on the surface, producing a perfect coating which penetrates more efficiently into the interstices of the bricks.

#### THE FRANKLIN MOVING SYSTEM OF CONCRETE WALL CONSTRUCTION.

A number of moveable forms of lightweight metal construction is used in this system. A form is placed in position, filled with a dry mix of concrete and is well tamped. The forms are moved to the next adjacent position as soon as tamping is finished and the process is repeated. A complete set of forms is available for an ordinary dwelling house and 120 cu. ft. of concrete can be laid in one day. A 1 to 8 mix is generally employed. Three men are sufficient to carry on the work.

No. 8—August 1937.

### NEWS & NOTES.

#### ELECTRIC CURING OF CONCRETE.

The process of hardening of newly poured concrete is greatly accelerated by the heating effect of a low voltage current passed through the concrete between suitable electrodes. Alternating current is used to prevent electrolysis. This method of curing has been largely applied in Russia. Tests indicate that electric curing of freshly cast concrete cubes for 24 hours results in the strength of the material being 95 p.c. of the 28th day strength of untreated concrete.

# **OBSERVATIONS ON THE INDIAN RAILWAY CODE OF PRACTICE FOR REINFORCED CONCRETE CONSTRUCTION.**

Desai.  
Shahani.

This paper is a sequel to two others published in the Indian Concrete Journal in July 1936 and April 1937 and aims at providing an easy method of designing reinforced concrete structures. Improved materials and methods of working make it possible to allow higher stresses than those hitherto allowed. The Indian Railways have accordingly adopted a new Code with increased permissible stresses. The authors have prepared a number of charts which accompany this paper and are useful for designing reinforced concrete slabs and beams in accordance with the new code. The charts save laborious calculations and time. The equations which form the basis of the charts have been worked out by standard methods, and practical examples illustrating the use of the charts are given.

## **CONCRETE PILE DRIVING.**

McCarthy.

Discusses factors which should be taken into consideration in concrete pile driving. The causes of damage to concrete under severe driving conditions are discussed, and the precautions to be taken are indicated. Test piles, test loading of piles and settlement of piles are discussed, and from amongst the many pile driving formulæ in use, the Hiley formula is considered the only one which is theoretically sound.

## **VIBRATION FOR CONCRETE ROAD CONSTRUCTION.**

Describes a new type of machine for vibrating concrete in road construction. It is called a pervibrating machine, the term pervibrating being used to indicate internal vibration as distinguished from surface vibration.

## **LARGE SCALE VIBRATION OF CONCRETE.**

Dixon.

A brief description is given of a mechanical vibrating apparatus specially constructed for the slopes of the inlet canal of the Champanubert reservoir in France. The total length of the canal is 3 miles, and it has a bed width of 13 ft., a depth of 6 ft. and a top width of 34 ft. The concrete is 6 inches in thickness.

*No. 9—September 1937.*

## **NEWS & NOTES.**

### **EUROPE'S LARGEST CONCRETE BUILDING.**

This is the new exhibition building at Earl's Court, London. The structure which is entirely of reinforced concrete covers an area of 9 acres. The roof over the central arena has a span of 350 ft. by 250 ft. without intervening columns and is 120 ft. above ground floor level.

### THREE-SPAN REINFORCED CONCRETE BRIDGE DESIGN IN THE ISLE OF ELY.

Hill.

The old bridges over main drains in the Isle of Ely are being replaced as they are unsuited to modern traffic. Various types of 3-span bridges have been designed and these articles deal with the design of the three following types.

1. Continuous three-span.
2. Three-span with cantilevers and suspended slab centre span.
3. Continuous centre span with end cantilevers.

This is the first article of the series and deals with the continuous three-span type. Details of calculations are given.

### NEW TENDENCIES IN CONCRETE ROAD CONSTRUCTION.

Quennessen.

Describes new developments in road construction methods in France.

### NOTES ON VIBRATED CONCRETE.

Discusses the advantages of vibration and its effects on the concrete. Speed of vibration, grading as related to vibration, extra material required for vibrated concrete, and effect of vibration on cost are some of the other points which are discussed. The requirements for satisfactory vibration have been laid down and it is pointed out that vibration can do more harm than good if it is not properly used.

### CURING CONCRETE ROADS AND FLOORS.

Satisfactory results are claimed for a product called "Sisalkraft" which can be used in covering up newly laid concrete to prevent evaporation and help in curing the concrete. The method generally used now is to cover the wet concrete with a deep layer of sand kept wet by sprinkling with water. If "Sisalkraft" is spread on the concrete the evaporation is practically suspended. It is a type of fabric obtainable in rolls and the same piece can be used several times on different surfaces without fear of fracture.

### INDIAN ENGINEERING.

Vol. CII.

No. 1—July 1937.

### REINFORCED BRICKWORK.

Vasudevan.

Contains a discussion of the theory of design of reinforced brickwork and a practical method of designing reinforced brickwork structures. A few actual examples have been worked out and the advantages of reinforced brickwork construction are given.

## U. P. HYDRO-ELECTRIC GRID, STATE TUBE WELL SYSTEM.

The hydro-electric scheme comprises six power stations on the Ganges Canal in operation and a seventh under construction. A steam driven station has also been constructed to carry peak loads during the irrigation season. About 1,300 tube wells are in operation out of the total projected number of 1,500. Each tube well commands about 1,200 acres and is designed to irrigate 240 acres of rabi, 125 acres of sugarcane and 60 acres of other kharif crops. Total area to be irrigated by tube wells is estimated to be 625,000 acres out of a total commanded area of 1,750,000 acres.

## KHYBER AGENCY IRRIGATION.

A scheme consisting of a dam across the Khyber river at the point where it debouches from the hills was recently investigated from the geological point of view. The object of this proposed scheme was to irrigate land in the Khyber Agency. The main features of the scheme and the geology of the various sites proposed and examined are discussed. The scheme has been shelved for the present for financial reasons.

## FRENCH ENGINEERING ACHIEVEMENTS.

A general description is given of some of the outstanding engineering works in France during recent years. These include the Elorn bridge, a reinforced concrete arch bridge with three spans of 610 feet, each carrying a double deck, the upper one for the highway and the lower one for the railroad. Each arch is composed of two hollow arcs of rectangular cross section. The design is due to M. Frayssinet, the celebrated French engineer.

Hydro-electric schemes have been greatly developed in France in recent years. Some of the dams are described. The Chambon Dam is a gravity dam, 960 ft. long, and 445 ft. high, and is next only to the Boulder Dam in height. A few other dams are described and mention is made of some of the difficulties encountered and solutions adopted.

Another important work is the Rove canal tunnel. The Rove canal connects the port of Marseilles with the river Rhone and passes through a rocky barrier separating the two water levels. The canal passes through a tunnel in the rock for a distance of 4.6 miles and is 72 ft. wide with a depth of water of 13 ft. This is the largest underground canal in the world.

## SUPPLEMENT TO "INDIAN ENGINEERING", JULY 1937.

This Supplement gives a new schedule of rates of building and engineering works within and outside Calcutta and the Bengal Presidency.

*No. 2—August 1937.*

### LETTERS TO THE EDITOR.

#### LIMITING REGIME DISCHARGES.

Mr. Gerald Lacey in this letter refers to an article published in the June number of Indian Engineering (See page 66 of Bulletin No. 6) and says that the subject could be dealt with in a simpler manner. He also refers to certain equations derived in the original papers and points out that some of them are incorrect. He discusses the question of minimum stable perimeter in channels in incoherent alluvium, and the bed width: depth relationship of small and large channels. He expresses his agreement with the view of the author of the original article that the laws of discharges below the limiting regime discharges are different.

#### BUTTRESSED DAMS: MODERN DEVELOPMENT: FEATURES OF THE AMBURSEN SYSTEM OF CONSTRUCTION.

Lewis.

The essential features of a new type of buttressed dam construction patented in the U. S. A. are described. This type of dam is called the Ambursen Dam and is of reinforced concrete construction and it contains about 40 per cent. less material than a corresponding mass dam. There are two types of buttressed dams, one with massive buttresses and the other with thin ones. The two types are compared and the thin buttress type is said to be the more favoured type. The Ambursen dam is also of thin buttress type. The buttress dam is compared with the gravity dam and the advantages and disadvantages of each are discussed. Some examples of recent construction of this type of dam are given.

#### PUMPING SANDY WATER.

A centrifugal pump installation is being operated in England by a waterworks Company which is pumping water containing sand without any serious trouble.

#### UHL RIVER WATER POWER UNDERTAKING.

Features of the Mandi Hydro-electric Scheme in the Punjab are described in this article. (See page 121 of Bulletin No. 5).



No. 3—September 1937.

#### NOTES AND COMMENTS.

##### MALAKAND HYDRO-ELECTRIC PROJECT.

Describes the main features of the above project which is under construction in the North-Western Frontier Province. In the first stage, the power generated will be 20,000 k.w. and the cost will be Rs. 7½ lacs.

#### CURRENT NEWS.

Mr. T. M. Lyle, Chief Engineer, U. P., recently toured the flood-stricken areas of the Eastern Districts of U. P. He has drawn up a detailed plan which if carried out will minimise damage from floods in future. A number of projects are under consideration in this connection.

#### LETTERS TO THE EDITOR.

##### LIMITING REGIME DISCHARGES.

Mr. Khushalani, the writer of the original paper replies to Mr. Gerald Lacey's comments on his article.

#### ROLLING THEORY OF WATER.

Khushalani.

In this article the author puts forward a new theory of movement of water. According to him, there is no streamline motion of flowing water but what actually happens is that water rolls along, the particles describing vertical cycloidal curves alternately touching the bed and the surface. That the assumption of rolling action does not affect the Chezy formula has been proved by the author. The author has advanced a formula  $V = m\sqrt{fZ}$  where  $V$  is the velocity,  $m$  is a constant,  $f$  is the silt factor and  $Z$  the lever arm of the couple causing the rolling action. He refers to Mr. Gerald Lacey's paper on "Stable Channels in Alluvium" wherein he advocates the use of  $R$  the hydraulic mean radius for calculating critical velocities and proceeds to show that hydraulic mean radius could not be a criterion for velocity. He has applied Mr. Lacey's results to some types of sections and argues that certain inconsistent conditions arise while with the writer's lever arm theory these conditions can be rationally explained. His contention is that while Mr. Lacey's formulæ do not stand mathematical tests, his own formula does. He also shows that his formula fits in with observed data as well, and offers an explanation as to why Mr. Lacey's theory, though mathematically inconsistent, agrees so well with observed data.

## INDIAN ROADS.

*No. XI—June 1937.*

### THE MINISTRY OF TRANSPORT EXPERIMENTAL ROAD.

The first set of experiments was directed to the determination of the effect of various factors in the design of concrete roads and to investigate the effect of weather and traffic on the behaviour of concrete road slabs. The various factors considered were thickness of concrete slab, water cement ratio, effect of steel reinforcements in slabs, and the use of different lengths of slabs. Some of the conclusions arrived at in respect of the above factors are set forth. Other investigations included measurement of temperatures at the top and bottom of the slab, observation of curling of slab due to temperature changes, and abrasion of cement by traffic. Observations were also made on the deflection of the slab. Results of observations are given.

### THE PERMEABILITY OF PAVEMENTS.

This article contains brief descriptions of some types of apparatus used to determine whether a road surface is impervious, and if not, the rate at which water passes through the surface.

### CONCRETE PAVEMENT FAILURES DUE TO HIGH-LIME CEMENT.

Paul.

The author discusses some cases of pavement failures in New York state which are due to the use of cements with high lime contents. In conclusion he says that the question of increasing the life of concrete roads can be solved through the production of low-lime cements.

### FATIGUE OF CONCRETE.

Considerable research has been done on the fatigue behaviour of concrete or its action under repetitions of stress. Main conclusions of these researches are given and a graph is reproduced showing the fatigue behaviour of concrete in flexure.

### DEMONSTRATION ASCU TREATED TIMBER HIGHWAY BRIDGE AT LUCKNOW EXHIBITION.

This highway bridge was designed and built by the Forest Research Institute, Dehra Dun, to demonstrate the utility and economy of treated wood for bridges. The span is 48 ft. and the bridge is capable of carrying a ten ton steam roller and a crowd of people. A service of 30 years may be expected from this type of bridge.

## EXTRACTS.

Under this head are included abstracts of literature on highway engineering from various countries. Some of these may be mentioned.

1. Contributions to the experimental study of cement bound macadam roads.
2. Apparatus for measuring the stresses in concrete slabs.
3. Cracks and sinks in concrete.
4. New road surfacings in reinforced concrete.
5. Frequent and avoidable faults in concrete road construction.
6. Soil stabilization work in Jackson County. Stabilization methods for earth tracks are described.
7. Russian experimental tarred earth roads. Stabilization of earth roads in heavy loam soils with tar is described.
8. Brick road paving.

## SCIENCE AND CULTURE.

VOL. II.

No. 9—March 1937.

SOME PLANT DISEASES AND PESTS OF INDIA AND  
THEIR CONTROL.

Mitra.

Continued from previous issue. Some diseases of cereals, sugarcane, fibre crop, pulse crop, oil seeds, spice crops, fruit trees and forest trees are described, with remedies for their control.

VOL. 3.

No. 1—July 1937.

VERNALIZATION—A NEW RUSSIAN METHOD OF CROP  
PRODUCTION.

Mitra.

The most remarkable achievement in agriculture during recent years has been the Russian discovery that by suitable treatment of the seeds before sowing crop production can be greatly hastened. This process was discovered about 1928 and is known as vernalization. The precise method of vernalization varies with different plants. The process applied to winter wheat is as below. Winter wheat seeds are first soaked in water, the weight of the absorbed water being limited to 50 per cent. of the dry weight of the seed. The seeds are kept in water for one or two days at room temperature when they get swollen and embryos begin to emerge from the seed coat. They are then kept in darkness at a

temperature of 35-36°F. for 40 to 50 days. After this period the process of vernalization is complete and the seeds are ready for sowing. The vernalized seeds are outwardly quite similar to the un-vernalized ones, but differ in quality. The practical utility of vernalization is the possibility of obtaining two crops in one season. In Russia, the unvernallized winter wheat takes 92 days from the date of sowing to earing while the vernalized crop takes only 54 days. The yield has also been found to be much greater, and other qualities such as drought resistance, size, quality, and weight of the grains are also increased. In India however, results of tests on vernalization have not been promising so far. Probably the Indian forms require different sets of conditions, and further research work is needed to determine these. The Indian varieties have however yielded encouraging results at the hands of Russians.

*No. 2—August 1937.*

#### NOTES AND NEWS.

##### THE CONTROL OF RAGING WATERS.

The editor comments on the ravages and destruction caused by floods in American rivers. Bank erosion became a serious menace until a new method of bank protection was developed, which consists of a solid concrete dyke facing. The editor says that conditions in Bengal are the same as in America, and a wise and comprehensive planning on a scientific basis is required in Bengal to cope with the problem of its rivers.

##### INDIAN SCIENCE CONGRESS—DISCUSSIONS.

Gives the discussions which have been tentatively arranged for the Jubilee meeting of the Indian Science Congress. Under the section of Mathematics and Physics will be discussed the subject of River Physics in India.

##### IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

##### ANNUAL REPORT.

The editor reviews the annual report of the Imperial Council of Agricultural Research for the year 1936-37. Research schemes financed by the Council form a considerable part of the report. The research work carried out at the various research stations all over India subsidized by the Council deals mainly with breeding and cultivation of rice, sugarcane breeding, means of fighting insect pests, and rust research. An increasing amount of attention is being given year by year to fruit research.

# PROBLEMS OF RIVER PHYSICS AND HOW THEY ARE SOLVED.

Bose.

In modern times knowledge of science is being applied to almost all forms of human activity, and river engineering science has developed to a remarkable extent during recent years. It has been found that laws of river physics can be as effectively studied in the laboratory as those of stellar physics in a physicist's laboratory. The author then proceeds to explain how a river model is constructed in a laboratory and the procedure of fixing the scale ratios. He explains Reynold's number in relation to turbulent and laminar flow and shows that unless the vertical scale is suitably exaggerated, a very small depth will be obtained in the model and the Reynold's number will be very small so that the flow will not be turbulent as in the actual river. With a small depth in the model the velocity will not be sufficient to move the silt in the bed of the model. He then discusses how it is possible to reproduce silt movement correctly in the model. The selection of discharge scale and time scale is then explained.

## IRRIGATION IN INDIA.

Review of Central Board of Irrigation Publication No. 14, the Annual Report (Technical) of the Board for the year 1935-36. In commenting on the Hardinge Bridge experiments carried out at Khadakvasla, the editor says that the Ganges is the main flood carrier in Bengal but most of the flood water passes through the eastern arm of the Ganges which lies in Eastern Bengal, causing widespread erosion while Central Bengal is a land of dead rivers. If some of the water in the eastern arm of the Ganges known as the Padma could be diverted through certain spill channels which formerly used to distribute the Ganges spill over Central Bengal, a permanent solution might be found for the Hardinge bridge and Central Bengal would have benefited enormously.

The Sara Bridge was constructed at the insistence of the Bengal Chamber of Commerce on a site which was condemned by the Investigating Engineer, Sir Francis Spring, who also drew the attention of Government to the necessity of investigating river problems in a properly organized river physics laboratory before any large engineering work is taken in hand.

REVISTA DE LA SOCIEDAD CUBANA DE INGENIEROS.

(In Spanish.)

VOL. XXX

No. 6—June 1937.

THE ABUNDANCE OF TECHNICAL LITERATURE AND  
THE CONVENIENCE OF ITS CLASSIFICATION.

Editorial notes.

No. 7—July 1937.

No. 8—August 1937.

These contain nothing of interest to irrigation engineers.

IRRIGACION EN MEXICO.

(In Spanish.)

VOL. XIV.

Combined Nos. 1, 2 and 3—January—March 1937.

ORGANIZATION AND FUNCTIONS OF THE NATIONAL  
COMMISSION OF IRRIGATION.

THE HYDROMETRY SERVICE OF THE NATIONAL  
COMMISSION OF IRRIGATION.

Alfonso de La O.

This article describes the various gauging stations and the methods employed.

PRELIMINARY STUDY OF AGRO-ECONOMICS.

Bernabe Pena.

CONCRETE PROPORTIONS.

Federico Barona.

An article on investigations carried at the Bureau of Reclamation Laboratory at Denver, Colorado, U. S. A.

HELICAL TURBINES.

HELICOIDAL PUMPS.

AGRICULTURAL ENGINEERING.

VOL. 17.

No. 9—September 1936.

WATERSHED AND HYDROLOGIC STUDIES IN SOIL  
CONSERVATION.

Ramser.

The Soil Conservation Service, U. S. Deptt. of Agriculture are to conduct studies of the effect of erosion control practices

on conservation of water and control of floods. Reasons justifying the need of these studies are discussed. They are also to conduct hydrologic studies of rainfall and run-off for use in the economic design of erosion and flood control structures. The problem consists of a detailed and comprehensive study of the action of water from the time it reaches the surface soil until it leaves the watershed as surface or ground flow. It will include studies of precipitation, percolation, co-operation, transpiration, surface and underground storage and rate of movement over the ground surface and through stream channels. The general plan of study is described and the field procedure is outlined.

#### APPLICATION OF RAINFALL INTENSITY-FREQUENCY DATA.

Yarnell.

A bulletin of the U. S. Deptt. of Agriculture entitled "Rainfall, intensity-frequency data" gives a rational formula for the computation of run-off from rainfall intensity-frequency data. Certain factors which have not been fully covered in the bulletin are discussed in this article.

#### NEW DEVELOPMENTS IN TERRACING IN THE SOUTH-EAST.

Nichols.

Terracing as an erosion control measure as practiced in the South-east of U. S. A. is described in this article.

#### AGRICULTURAL ENGINEERING DIGEST.

Current literature on Agricultural Engineering and other connected subjects is reviewed under this section. The following papers amongst others are mentioned :—

1. "A formula for capacities of reservoirs" by G. C. Dobson. Soil conservation U. S. (1) 1936. A formula is described which was developed for computing original and present capacities and silt volumes in storage reservoirs.
2. "Recent results of engineering experiments in soil and water conservation at the soil erosion experiment station, Tyler, Texas" by R. W. Baird. Proceedings of the Southwest Soil and Water Conservation Conference, Tyler, Texas, 1935. Data on run-off and soil losses from field areas with different characteristics and from different types of terraces, on erosion control in terrace outlet ditches and gullies, and on the use of farm machinery on terraced land, are summarized.

# JOURNAL OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

Vol. XIX.

No. 2—*May 1936.*

This issue of the journal contains proceedings of the fifty-first annual convention of the Association held at Washington in November 1935 and the papers contributed to the convention. The "proceedings" section contains the following reports:—

Report on soils and liming materials.

Reports on hydrogen-ion concentration of acid and alkali soils.

These reports deal mainly with determination of pH values of soils and the use of different types of electrodes for this determination. Some of the reports deal with the analysis of fertilizers of various sorts.

## THE AMERICAN CITY.

Vol. LII.

No. 7—*July 1937.*

### LEAD AS SHOCK ABSORBER ON SEATTLE BRIDGE.

Sheet lead has been used to reduce vibration in a bridge in Washington. The bridge is constructed of precast and precured concrete slabs resting on horizontal steel girders. The slabs weigh about 2 tons each, and are bolt anchored to the steel understructure. Sheet lead plates were laid over the entire area between the concrete slabs and the steel girders. In addition to its role as shock absorber the layer of lead takes up any differences in the surface of the steel and concrete permitting a perfect settling of the two materials and compensating for surface irregularities. Cracking of the slab under concentrated load is also prevented.

## CHEMICAL ABSTRACTS.

Vol. 30.

No. 19—*October 10, 1936.*

(A key to the world's chemical literature, published fortnightly by the American Chemical Society.)

Under the section of soils, fertilizers and agricultural poisons, the following publication is mentioned among others:—

"The evaluation of irrigation waters" by Varallyay and Fejer.



For quick evaluation of irrigation waters, the detection of dry matter content, alkalinity, total hardness, and soda content is needed. Waters can be used for irrigation if their content of dry matter is below 500 mg./l and they contain no soda. Methods are proposed for the detection of these data.

Under the section "cement and other building material" the following publications are given.

1. Acid resistant cement and their chief properties.
2. A quick analysis of cement.
3. White cement.
4. Tar as road material.
5. Concretes.
6. Revetment mats for protecting river banks.
7. Solidifying pervious subsoil layers.
8. Compositions for filling cracks in concrete.

The water, sewage and sanitation section mentions the following.

1. Study of the water and silt of the Nile.

#### CIVIL ENGINEERING (NEW YORK).

VOL. 7.

No. 6—June 1937.

#### THE MISSISSIPPI MEETS THE 1937 FLOOD.

Clemens.

In January 1937 a superflood which had reached record heights in the Ohio River rushed on to the Mississippi. People watched with anxiety the effect of this flood on the recently completed Jadwin flood control plan. The Jadwin plan was supplemented by a system of cut-offs constructed at the instance of General Ferguson, the President of the Mississippi River Commission since 1932. The well-nigh perfect functioning of the levee system, the floodways and the cut-offs was a thorough justification of the protective methods now employed for the Mississippi River. The 12 cut-offs completed have shortened the length of the Mississippi River by about 100 miles.

The city of Cairo is situated at the junction of the Ohio and Mississippi Rivers and the levees protecting the city were raised and strengthened to withstand a flood stage of 60 ft. The New Madrid Floodway was designed to reduce flood stages in Cairo and the fuse plug levee at the head of the floodway was blown up with dynamite to pass a portion of the flood in the floodway. This saved the city from being flooded. Below Cairo on the Mississippi River, flood stages were higher for about 200 miles than ever

before but the raised and strengthened levees held the flood waters in control. In the lower reaches of the Mississippi, stages were much less due to the functioning of the cut-offs and improvements in river channel. At the mouth of the river, the Bonnet Carre spillway was opened to save the city of New Orleans which otherwise would have been under water. A table giving the stages and estimated flood flows at different points along the river shows that the 1937 flood established record heights in a reach of 300 miles below Cairo.

#### **GEOLOGY OF DAM SITES IN SHALE AND EARTH.**

**Mead.**

Properties of shale, gravel, sand, silt and clay as foundations for masonry and earth dams are discussed in this article. The term shale is used to denote all fine grained sedimentary rocks originally deposited as clay or mud and compacted by natural process at a later stage. Distinction is made between compaction shales which have been consolidated by compaction alone and cemented shales which have undergone a cementation or setting process. Compaction shales are plastic and disaggregate in water. They may appear adequately strong in the dry condition but will slake disastrously under the action of water. Cemented shales are much more reliable. The bearing strength and elasticity of the two forms of shales and their behaviour under load are discussed. Precautions necessary in preparing shale foundations for concrete are set forth.

The treatment of earth dam foundations consisting of boulder deposits, gravel, sand or mixtures of these materials involves only the question of control of leakage through the foundations. This type of materials calls for thorough field and laboratory investigations of its permeability. River deposited silt is laid down with a high percentage of voids and is susceptible of compaction under load of the dam provided there is adequate opportunity for escape of water. If the load however is applied too rapidly there is tendency for the silt to flow from under the load. Clay is plastic and has the properties of a viscous fluid, having little bearing strength unless adequately restrained on all sides. It is incapable of supporting more than very moderate loads.

#### **THE MODERN TREND IN BRIDGE DESIGN.**

**Ogden.**

Discusses modern types of steel deck type bridges which are a marked improvement over the old truss types. Improved materials, electric welding, use of beams instead of trusses, ingenuity in selecting types suited to different conditions, and increased attention to esthetic treatment have all contributed to the improved types of modern bridges.

**FLOOD CONTROL AT CHATTANOOGA.****Chandler.**

This article describes the development of the flood control plan shortly to be started for Chattanooga District on the Tennessee River. The works consist of levees, cut-off channels, storm sewers, and flood gates. The physical features of the watershed are described and the problems that were presented in evolving a flood control plan are discussed.

**ENGINEER'S NOTEBOOK.****HYDRAULIC MODELS USED IN DESIGN OF PARKER DAM.****Perlitter.**

In the design of Parker Dam, hydraulic models were called upon to solve a variety of problems including the selection of the best type of dam, arch or gravity, the determination of the proper shape of the overflow crest, the most desirable operating conditions, and the best shape for the entrance approach to the gates. The model was constructed on a scale of 1:80.

Various crest profiles experimented upon are depicted and finally a profile with a steep slope was found to give the minimum action downstream. One gravity dam model and two arch dam models were tested with different types of crests and finally the arch dam with a sloping crest was selected as being the most economical.

**THE WORK OF THE BRITISH STEEL STRUCTURES RESEARCH COMMITTEE.****Fleming.**

The British Steel Structures Research Committee was appointed in 1929 to review present methods and regulations for the design of steel structures, to investigate the application of the modern theory of structures to design, and to recommend the translation into practice of such results as would lead to more efficient and economical design. Three reports issued by the Committee are reviewed briefly in this article. The items considered in the reports are loads on floors, strains in buildings, stress analysis, specifications and properties of materials, welded connections, and vibration. Recommended rules of design with regard to loads, stresses, and other factors are given.

*No. 7—July 1937.***RECTIFICATION OF THE RIO GRANDE.****Lawson.**

The Rio Grande River constitutes the boundary between the United States and Mexico for a distance of nearly 1,300 miles. Owing to characteristic changes in the channel of the river such as erosion and avulsion, and increased flood

hazard in certain sections of the river valley it was decided that the International Boundary Commission should conduct studies relating to the defining of the land and water boundary between the United States and Mexico, to flood control, conservation and utilization of water, channel rectification and stabilization, and to other related matters. This article describes the projects evolved as a result of these studies. The rectification project for the upper reach of the Rio Grande includes the construction of the Caballo Dam which is a flood detention dam, and straightening of the river channel between levees in a length of nearly a hundred miles. This project was started in 1933 and is nearly completed. The lower Rio Grande Flood Control project includes the following features: raising and strengthening about 300 miles of River and floodway levees, clearing about 150 miles of floodways, construction of protective works to prevent flood damage to irrigation structures crossing the floodways, and construction of structures to control distribution of flood waters between the floodways. The river and other surveys now in hand are briefly described. The collection of hydrographic data is an important part of the investigations being carried out.

#### IRRIGATION FROM PUMPED WELLS.

Holbrook.

Well water has a number of advantages over surface supplies for irrigation, among them being its relative invariability in quantity and less wastage. Well irrigation was not in general use in the U. S. A. at the beginning of the present century but it was a common practice in older countries. In India for example, 850,000 pumps were being used in 3 Provinces alone to irrigate 4,000,000 acres of land from wells. In U. S. A. large scale practice of well irrigation began about 30 years ago. Groundwater in large quantities may be present in the refill of broad stream valleys and in beds of sand and gravel in inland basins. These are the sources more commonly exploited in the U. S. A. The various types of wells which are suitable for different conditions of occurrence of ground water are discussed. In artesian areas the wells are of small diameter and are encased from the top of the ground to the pressure stratum. The rotary drill is used in drilling deep wells. If the water is in shallow deposits, a large diameter well is necessary or the area is covered with a number of wells of small diameter all connected with a central pumping pit. The different types of pumps suitable for different conditions are mentioned. The most widely preferred type for general use is the vertical turbine pump. Pumping costs are discussed.

**GROUND AND SURFACE WATER PROBLEMS WITH  
PARTICULAR REFERENCE TO THE DEVELOPMENT OF  
WATER RESOURCES IN TEXAS.**

Turner.

Groundwater is one of the principal natural resources of Texas. In recent years these resources have been taxed to the limit in many localities with the increasing development of the State. An investigation has been started to obtain accurate information regarding the quantity of groundwater in the various sections and to evolve the most effective measures for utilizing and conserving these resources. The lines on which these investigations are being carried out are described. Two factors which limit the amount of groundwater to be withdrawn safely from a stratum are:—the average annual recharge to the stratum, and the capacity of the stratum to transmit the water to the pumped area. Three quantitative methods are used in determining the safe limits of ground water withdrawal. These are called the recharge method, the transmission method, and the discharge method. These methods are described. In some parts of the country beds containing highly mineralized water overlie the sands containing fresh water. The mineralized water is likely to corrode the well casing and enter the well. Methods used in detecting the location of salt water leaks are described. A special electrical apparatus is used for the purpose. Other special cases to be tackled are salt water encroachment from the gulf and leakage of water from artesian strata resulting in waterlogging of certain areas. Such leaks are detected by deep well current meters.

**ORGANIZING FOR WATERSHED DEVELOPMENT.**

Forrest.

Describes the policy of development of watersheds on an organized basis as adopted in Texas. As an instance of the objectives of watershed development in the State the following programme for a particular area is given: Soil and water conservation: embraces land use survey, strip cropping, contour furrowing, terracing, check dams, and reservoirs. Drainage and flood control: embraces levees, ditching, and channel rectification. Submarginal land retirement: embraces reforestation and provision of grazing land.

The programmes are being carried out from State and Federal funds.

**THE NEW GALVESTON CAUSEWAY.**

Bartlett.

Describes a new causeway under construction across Galveston Bay in U. S. A. The main structure consists of continuous reinforced concrete girders with integral deck slab.

The girders are continuous in sections covering three spans 201.5 ft. between the through expansion joints. There is a drawspan with flanking spans occupying 276 ft. and the spans next to the abutments are 30 ft. each. The total length of the structure is 8,194 ft. The piers consist of two cylinders stiffened by a strut and by the rigid frame composed of the two cylindrical posts with the connecting cross girder below the decking. This open type of pillar construction is a special feature. The pier cylinders rest on caissons some of which down to a depth of 36 ft. and resting on 16 to 19 piles. The concrete pier cylinders are reinforced.

#### **IRRIGATION OF RICE IN THE UNITED STATES.**

Gustafson.

This article deals with problems involved in the production of rice in the United States such as design of canals, flumes, and pumping plants. It also gives some interesting facts about rice culture in general and discusses the 'duty' of rice as obtained in the United States. Rice in the United States is not grown in the marshes but on irrigated level land of a heavy texture with clay subsoil through which there is little loss by seepage. The United States grows about 0.5 per cent. of the total world production of this crop. The normal world production is 440 billion lbs. of rough rice yielding 273 billion lbs. of clean rice which is equivalent to 100 lbs. for every man, woman and child on earth. The climate suitable is mild with a mean temperature of 70°F. or above during the growing season. Water is first applied when the plants are 4 to 6 inches high. Irrigation is by a system of controlled inundation with contour levees. The area served by one cusec of water in rice irrigation as measured on 18 representative rice fields in the Sacramento valley was 47 acres and the average depth applied to the fields was 8.23 ft.

#### **AIR-MAPPING THE BRAZOS RIVER AREA.**

Haquinus.

The proposed plan for the control of the Brazos River in Texas calls for a chain of 13 major dams on the main stream and its principal tributaries. The topographic maps of the reservoir areas were prepared from aerial photographs by the stereoscopic plotting method, and a new machine was used for the work. The field work involved in preparing the base sheets, or skeleton sheets, is described. Photogrammetrists build up the map on these base sheets with the plotting machines. A description of the machine and its manipulation is given, and some advantages of preparing maps by the aerial photography method are discussed.

**MEASUREMENT OF IRRIGATION WATER.****Kidder.**

This article describes various types of metres available for the measurement of water in canals and closed conduits and emphasizes the importance of extending their use.

**OUR READERS SAY.****PRESSURE DISTRIBUTION AND ACCELERATION AT  
THE FREE OVERFALL.**

In this note to the editor Mr. Hunter Rouse comments on the article on Discharge Over a Free Fall published in the May 1937 issue of this journal. (See page 81 of Bulletin No. 6). He says that certain assumptions upon which the writer of the original article has based his developments are contrary to fact, and therefore the significance of his derivation of a new formula is open to question.

*No. 8—August 1937.*

**THE PROGRESS OF IRRIGATION IN NORTH CHINA.****Todd.**

During the past decade, a number of irrigation projects have been developed in North China to conserve more thoroughly the available flow in the principal streams. In this movement, engineers who have studied western irrigation technique have endeavoured to introduce more modern methods of construction. Four of the larger and more important projects are discussed in this article. All the projects discussed consist of diversion dams across the rivers and systems of canals taking off from the rivers. The main features of the diversion dams are described. In two cases the diversion dams are constructed in rocky gorges of the rivers and the water is led into tunnels through the rock whence it emerges and flows in open channels, which form the irrigating system.

**SETTLEMENT STRESSES FOUND WITH A MODEL.****Bull.**

Stresses in a statically indeterminate structure can be easily determined by the use of a wire model. Some recent improvements in the methods used are described. The solution of a practical settlement problem in connection with a multiple frame structure by wire model analysis is described in detail. In conclusion the writer emphasizes the value of models in investigation of behaviour of structures and points out the advantages.

**TECHNIQUE OF SOIL TESTING.****Buchanan.**

At the U. S. Waterways Experiment Station at Vicksburg a special section has been devoted to the study of soil mechanics since 1931. At present it is busy with studies

for many projects involving the use of earth as an engineering material. The present article describes the technique employed in performing the more important routine tests and gives examples of their use in the design of levees and earthen dams. The steps in the solution of a levee or an earth dam problem are sampling, testing, and the application of the data obtained to the solution of the problem. Soil sampling equipment and procedure are described. Soil testing consists of mechanical analysis, shear tests, determination of rate and amount of settlement, and permeability tests. The last one is very important because it relates to seepage through a levee or dam. The permeability tests are carried out on scale models constructed in glass sided flumes. The application of the data supplied by some of the tests is illustrated by explaining part of the general design of a levee.

#### **COLORADO RIVER WATER FOR CALIFORNIA.**

Hinds.

The cities of Southern California have few local sources of water, and a scheme for supplying this area with water of the Colorado river stored in Lake Mead behind Boulder Dam is in course of construction. The scheme consists of a dam called the Parker Dam 155 miles downstream of the Boulder Dam on the Colorado river. Water will be released from the Boulder Dam into the river channel and will be diverted at Parker Dam into a line of waterways known as the Colorado River aqueduct which will convey the water to Southern California some 300 miles away. The main Colorado River aqueduct consists of a series of concrete lined tunnels, concrete pipe lines, buried concrete flow-line conduits, and concrete lined open canals with a total length of 242 miles. The system is designed to carry a discharge of 1,500 cubic ft. per sec. on the average.

The area to be served being very much higher than the water level at Parker Dam, the water will be pumped at five pumping stations along the line with lifts varying from 144 ft. to 441 ft.

Many details of this great work are given and new methods developed in construction are briefly described. The present stage of progress of the work is reviewed.

#### **ENGINEERS' NOTEBOOK.**

O'Shaughnessy.

#### **DISCHARGE OF NEEDLE VALVES AND SLUICeways AT MADDEN DAM.**

Methods and results of testing the outlet structures at Madden Dam (located on the Chagres River, in the Isthmus of



Panama) are described in this article. The regulation works at the dam include two outlet pipes equipped with needle valves, and six rectangular sluiceways controlled by gates. Tests were made to determine the actual head-discharge relationship for both of these appurtenances. The relationship curves obtained are given for both works.

## COMPRESSED AIR MAGAZINE.

VOL. 42.

No. 1—January 1937.

### WATER TO MAKE THE DESERT BLOOM.

Coyle.

The All American Canal Project is described in this article. This is a part of the Boulder Canyon Project and includes a diversion dam on the Colorado River 250 miles below the Boulder Dam, an eighty mile main canal to Imperial Valley. The climatic and geological characteristics of the region to be supplied with irrigation water are discussed and figures of area to be irrigated and cost of the project are given. Some of the mechanical equipment used in excavation work is described. The All American Canal will be 160 ft. wide at the bottom and 232 ft. wide at water surface. The depth of water will be 21 ft. and the capacity of the canal will be 15,155 cubic feet per second. Construction features of the canal are described. A fill section 8,200 ft. long, 144 ft. wide at bottom, 27 ft. wide at top and 26 ft. high was specially constructed to prevent seepage. A line of sheet piling was driven under the fill line 30 ft. deep and special material was used for the fill which was compacted by mechanical rollers.

Features of the Imperial Dam which will divert water into the All American Canal are described. (See page 88 of Bulletin No. 5).

## CONTRACTORS AND ENGINEERS MONTHLY.

VOL. 33.

No. 5—November 1936.

### HOG WIRE STOPS STREAM EROSION.

A method of preventing erosion of banks of streams by velocity checks made of wire mesh fencing fixed to rails driven in the bed of the stream has been used with success in Arizona. Details of this form of check is given and the placing of these in the correct position is explained.

## DRAINAGE SWAMP LAND WITH VERTICAL DRAINS.

A portion of the approach highway to the San Francisco Bay Bridge lies over a swamp and is not stable enough for the highway embankment load. The California Division of Highways has formulated a theory that the swamp can be drained as the fill is being placed if suitable channels for the water are created before the fill is spread. These channels consist of vertical wells cut in the swamp and filled with gravel. The tops of these wells are connected to a system of drains filled with crushed stone and leading to the outside of the fill. The idea is that as the fill is being placed the water in the swamp will be pressed out by the weight of the fill through the vertical wells and the lateral system of drains out of the fill. This method is yet in the experimental stage. Details of the vertical and lateral drains and their construction are described.

## VOL. 34.

No. 7—*July 1937.*

## FURTHER DISCUSSION OF SCALING OF CONCRETE.

Some causes of scaling of concrete roads are described and effective treatments are indicated.

SYPHON AND BRIDGE CONSTRUCTION FOR ALL  
AMERICAN CANAL.

Coyle.

Some features of a few important structures for drainage, rail-road and highway crossings on the All-American Canal are described. These include syphons, bridges, and over-bridges. Important details as regards construction materials and plant are described.

## ASPHALT AS STABILIZING AGENT FOR SANDY SOILS.

A procedure of stabilizing sandy roads by asphaltic material is described in this article.

## SALT-STABILIZED TOWNSHIP ROAD.

A method of road surfacing is described which consists of spreading a layer of gravel on the subgrade and rolling it. Over the rolled gravel surface a layer of rocksalt containing 98 per cent sodium chloride was spread at the rate of 2 lbs. per square yard and the surface was again rolled. The road after treatment set up very hard and dense. Lime-stone dust was spread over the compacted surface to fill the surface pores while the surface was still moist.

## ENGINEERING NEWS-RECORD.

Vol. 118.

*No. 22—June 3, 1937.*

(Annual Waterworks Number).

**SELECTING PUMPING EQUIPMENT.****Burdick.**

Contains a general discussion of principles of selection of pumps for all purposes with particular reference to pumps for municipal water supplies. The gradual evolution of modern equipment from the crank and flywheel steam engine type of half a century ago to the modern electric centrifugal unit is traced.

**GROUNDWATER SURVEYS IN CINCINNATI AREA.**

Water levels in wells in this area have been declining gradually for many years. The water level has gone down 75 ft. since 1906. Information obtained during the recent investigations indicates that the possible causes of decline of water level include :—low rainfall in recent years; a change in the regimen of the Miami River following the construction of the flood control reservoirs of the Miami Conservancy district which may have reduced the possibility of groundwater recharge during periods of floods; the recent construction of a large intercepting sewer which has hastened the run off of both surface and groundwater; and the heavy and progressively increasing pumpage from wells.

**CURRENT NEWS.**

Completion of the two mile long spillway channel of the Fort Peck Reservoir will be a major construction operation this season. In the one mile long lined section, slots are cut in the shale of the sloping sides of the channel to act as keyways for the wall concrete. The shale was covered with cement mortar to check disintegration pending the placement of concrete.

*No. 23—June 10, 1937.***THE WEEK'S EVENTS.****\$800,000,000 FLOOD CONTROL PLAN.**

A flood control plan for the Ohio and Mississippi Rivers and their tributaries which will cost \$800,000,000 has been proposed by General Marham, Chief of Engineers. The scheme provides for the construction of numerous dams, creating detention reservoirs on the tributaries, miles of

levees and river walls, channel improvements in the rivers to provide greater waterway, and establishment of floodways on the Mississippi. General Marham appeared before the House Flood Control Committee and said it is a mistake to suppose that his organization opposes reservoir construction. In protecting the alluvial valley of the Mississippi, the problem was to obtain the utmost protection with the money to be spent, and this has meant levees and channel improvements. With more money available, the Corps of Engineers favours storage reservoirs for flood control, although the net result as measured by reduction in flood crests is usually disappointing to reservoir advocates. General Marham's report states that the 1937 flood in the Ohio was unprecedented. Had the fourteen reservoirs already authorized been in operation, they would have reduced the flood heights by 5.5 ft. at Pittsburgh, 1 to 2 ft. at Cincinnati and less than half a foot at Cairo. Additional protection besides reservoirs is therefore necessary.

#### COMMENT AND DISCUSSION.

##### CAUSES OF LAND SUBSIDENCE.

Refers to an article relating to the subsidence of land surface in the Santa Clara Valley in California published in the April 1, issue of the Engineering News-Record. The writer says that there is little doubt that frequently the subsidence of areas of great extent is caused by the drainage from them of liquids like water and oil. Rocks and other strata with voids permeated by water or oil are in effect like a solid body submerged in a liquid the weight of which in the immersed state is less than its actual weight due to buoyancy. When the liquid is extracted, the weight increases and there is subsidence. The increase in weight may be from 60 to 65 per cent. This point is brought to the notice of engineers and others interested in large oil fields where settlements are occurring.

##### RECLAIMING A RIVERFRONT.

Describes the essential features of a scheme of park development along a 7 mile front of the Hudson River in New York, which includes a retaining wall of ingenious design.

##### PUTTING SKID RESISTANCE INTO ROADS.

Some practicable processes for producing skid resistant surfaces are outlined in this article. Concrete surfaces may be made skid resistant by brooming the surface or by finishing it with a canvas belt. Both these operations bring the

sharp sand grains to the surface. Application of corundum, carborundum, emery recrush and similar abrasives to the surface of the green concrete is very effective on concrete stairways and offers a possibility in building skid resistant concrete roads. The modern de-aired, vertical fibre paving brick with lugs provides an excellent wear resisting gritty surface finish. Sand, gravel and cinders can provide a uniformly high resistance to skidding providing the surface is firm and reasonably free from loose material.

#### WELLPOINTS ON SMALL BRIDGE WORK.

Grover.

The use of well points for foundation work is usually limited to special and difficult problems but recently well points have been used with success in a few ordinary jobs in Kansas which include a few bridges across the Republican River in northern Kansas and a railway grade separation structure. Details of the well point installations used on these jobs are given. The installations were found particularly advantageous in fine sand that would leak through the joints of steel or timber sheeting.

#### FOUNDATION JOB INCLUDES MOVING A RIVER.

A steel sheet mill is being built in Cleveland on an eighty acre site in the bottom lands of the Cuyahoga River valley. The river actually flowed through the middle of this area in a horse shoe bend, the site occupying both banks of the river. A cut-off for the river channel eliminating the horse shoe bend was first constructed. This work required the digging of a new channel 1300 ft. long, 23 ft. deep and 200 ft. wide at the top with side slopes of 1:1. The river was diverted to this new channel and the whole site including the old channel was raised 5 ft. above the existing level with 75,000 cubic yards of fill. The mill buildings occupy 21 acres and 17,000 concrete piles were placed for the foundations. The piles consisting of steel shells with concrete cores, were driven 60 ft. to shale and are designed for a load of 35 tons each. A sheet pile wall was also erected along the mill side of the new cut-off channel.

#### NEW AIDS TO THE CONSTRUCTOR.

A hollow burned clay roofing type has been placed on the market. It is fireproof and has high insulating value. Purlin spacings up to 8 ft. may be used for the roof frame. The weight is 13 lb. per s. ft.

No. 24—June 17, 1937.

## COMMENT AND DISCUSSION.

### FLOOD CONTROL.

Mr. Salberg of Chittagong, Eastern Bengal, criticizes the policy of flood control by levees in the alluvial rivers of America. The writer says that all alluvial rivers carry silt which must be deposited somewhere. If the river is controlled by levees, the silt can no longer be deposited in the river's flood plain but is carried to the mouth to build up the delta and also to lengthen the river. To get its discharge the river must raise its bed and consequently the flood levels are also raised. The levees in time have also got to be raised to prevent over-topping. This process has its limit when it would no longer be possible to raise the levees higher or to increase the river's grade by straightening. Some scheme therefore must be evolved to build up the plains with river silt first to replace the natural building up of the plain which has been upheld during the past eighty years of levee protection, and after that to keep pace with the river's natural growth.

The only solution in the writers opinion is a system of controlled spillways designed to flood and build up sectional areas, each with its discharge channel back into the parent river. Under this scheme large areas will have to be taken up by the State for the period of their re-conditioning. The obsession of protecting the many interests that have grown up in the flood plains under levee protection must disappear from the minds of the American Engineers if permanent control of floods is to be achieved.

### A NEW TYPE OF CREST GATE.

Streiff.

The writer refers to an article on a new type of crest gate for the Emsworth Dam published in May 6, 1937 issue of the Engineering News-Record (See page 95 of Bulletin No. 6). He says that the design is not new at all and describes a lift-Tainter gate designed by him 20 years ago for an irrigation project in Siam. He considers however that for low dams in rivers with very high flood stages, the stoney, Roller and Tainter gates, dams are neither adaptable nor economical as the gates have to be lifted up high above the water level and require enormous piers, operating bridges and hoists etc. The piers in addition to their enormous cost, considerably restrict the channel area. For rivers with very high flood stages, preference should be given

to moveable dams requiring low separating piers, with modern forms of beartrap which are low in cost, quickly operated and adaptable for automatic operation.

#### SELF-ANCHORED EYEBAR CABLE BRIDGE.

McCullough.  
Archibald.

Describes a suspension bridge under construction in Guatemala. A special feature of the work is the use of eyebars for cables instead of wire strands. The bridge is of the self anchored type with a central span of 240 ft., and two 100 ft. flanking backstay spans. The horizontal tension component is taken by the bottom chord of the truss which carries the roadway. The truss is continuous, the bottom chord being rigidly fastened to the towers, one of which rests on a roller nest to allow free movement. The piers and abutments rest on a foundation of steel H beam piling. Details of the design are given.

#### FIRMING FINE SOIL WITH TAR.

Fahnestock.

This article describes some experimental road stabilization work undertaken in North Carolina with a view to ascertain whether a base which had proved inadequate could be stabilized and waterproofed by the use of bituminous material so that it would render satisfactory service. Two methods were employed. In the first method the existing road was scarified for a depth of 4 inches and the soil moved to the sides. Coal tar was then applied to the surface and was mixed with the soil material by a disc harrow. The material was then shaped and compacted by rolling. The compacted base was allowed to stand 36 hours after which the wearing surface which consisted of the same grade of tar as used for the base with half inch granite chips, was put on and rolled. A second method was to construct a 'sandwich' section which consisted of one inch of stabilized base soil covered by 5" thick untreated soil over which was another layer of 1 inch of stabilized soil. This top layer was covered over by the wearing surface as in the previous method.

#### FLAT SLABS ON 25-FT. SPANS IN EARTHQUAKE RESISTANT SCHOOL.

Hammill.

Describes some features of design of a recent school building in San Francisco. The building is a two storey reinforced concrete structure so designed that the walls, roofs, floors, and interior columns act as rigid frame units to resist earthquake stresses. Brief details of roof and floor slabs are given.

## FROM FIELD AND OFFICE.

## CLEANING CONCRETE SURFACES TO ENSURE BOND

McFarland.

Large blocks of concrete built in successive lifts at Grand Coulee Dam required such large areas of surface to be cleaned for adding fresh concrete that many cleaning devices were tried. Some of them which proved successful are described. These are :

- (1) Water-air jets. As soon as the concrete has set enough to stand it, the surface is cut with a jet of air and water. This takes off all the particles that are not firmly established in the concrete. The equipment consists of a Y shaped nozzle with connections for an air hose and a water hose. It is mounted on rubber tyred wheels and is moved along the surface of the concrete.
- (2) Jetting with Power brush. This involves the use of a power driven brush for cleaning the surface. A circular brush with steel wire bristles is put on an electric driven floor sander. The brush is also fitted with a water connection so that the surface will be washed free of the cuttings.

## A BETTER CROWN FORMULA FOR ROADS.

Cnare.

In Wisconsin, the transverse section of concrete pavements is

shaped in accordance with the formula  $Y = \frac{X^2}{100}$

where Y is the crown at any point and X the distance from centre line of the road to the point in question. This formula produces a curve which is rather flat at the top or crown of the road. The writer suggests a revised form of this formula which gives a slightly greater slope near the crown and less slope at the ends.

*No. 25—June 24, 1937.*

## NEWS OF THE WEEK.

## SMALL EARTHFILL DAM FAILS.

A small earthen dam in Colorado, 910 ft. long and 36 ft. high failed recently due to saturation of the fill. The dam was constructed in 1898 and a spillway for it was also excavated but was allowed to fall into disuse. In recent years a number of slips occurred due to saturation of the fill and drainage systems were installed as a corrective measure. A very recent slip extended to the crown and exposed a vertical face 9 ft. high, and the slip began to move. A



cut 4 ft. wide was made in the structure near the spillway to lower the water level but this widened rapidly and all the water was discharged in a few hours, flooding the town of Austin, washing away a hundred yards of a railroad, and causing widespread damage to crops.

#### COMMENT AND DISCUSSION.

##### SOIL LOSS IN POTOMAC FLOOD.

Love.

Information is presented herein on silt loads and corresponding denudation over a drainage basin related to one flood in the Potomac river. The April 1937 flood in this river had a computed crest discharge of 348,000 c. ft. per sec. The maximum rate of silt movement has been computed as 78,300 tons per hour, and the total load of suspended matter during the five days of the flood was computed to be about 2,210,000 tons. This quantity represents material spread evenly over the entire basin to a depth of .002 in. The maximum silt concentration was estimated to be 2.000 parts per million.

##### RECORD RIGID-FRAME BRIDGE.

Dunford.

Describes a cellular concrete bridge of 175 ft. span built in a park across a narrow ravine. The bridge is of the rigid frame type consisting of four large hollow concrete rigid frames set side by side. They are 8 ft. in width and of a depth averaging  $5\frac{1}{2}$  ft. at the crown and  $18\frac{1}{2}$  ft. at the haunches, where with a large circular sweep the horizontal girders connect with the legs, giving the appearance of an arch. The legs are of cellular construction, each terminating in a solid bottom 5 ft. by 6 ft. in section. The base is shaped in the form of segment of a cylinder to form rocker bearings. The base fits into a similarly shaped socket on the top of the footing. The design is briefly outlined and the procedure of construction is described.

##### FAST SUBAQUEOUS TUNNEL DRIVING.

A brief account of the tunnel scheme below the Hudson River in New York was given in the previous issue of the Engineering News-Record. This article describes the tunnel driving operations in some detail. The driving shield and the various mechanical contrivances appurtenant thereto are described. The shield is a circular structure 31 ft. 8 in. in diameter with a circular cutting edge. The face of the shield is fitted with a bulk head having two openings 2' 4" square controlled by hydraulic gates. The muck collected by the cutting edge is driven through these openings as the shield advances and is removed by men working on a moving platform, into a conveyor moving on belts.

## NEW AIDS TO THE CONSTRUCTOR.

A metallic lead pigment which is mixed with a suitable vehicle for application as a paint with brush or spray has recently been developed. The new product is said to be resistant to alkali, acid, fumes, and extreme temperature changes. It is recommended for buildings, bridges, water towers and steel structures generally, and as a seal coat on concrete.

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### VOL. 119.

*No. 1—July 1, 1937.*

#### CONTRACTORS WIN RIVER BATTLE.

Serious leaks occurred through the base of the Cofferdam which keeps the Columbia River out of the area in which the east section of the Grand Coulee dam is being built. A report on repair operations was published in an earlier issue of the journal (see page 93 of Bulletin No. 6). In this article additional information relative to conditions encountered and remedial measures adopted are given. It was discovered that cavities 1 to 3 ft. deep existed in the horizontal sand seam below the Cofferdam, through which water was flowing. Grout was pumped into these and observations were made to determine the best combination of ingredients for the grout. The following mixture was found to be the most suitable.

Sawdust . . . . .	8 cu. ft.
Shavings from refinishing machines . . . . .	10 cu. ft.
Portland cement . . . . .	2 cu. ft.
Sand . . . . .	6 cu. ft.
Lump bentonite . . . . .	50 lbs.
Water . . . . .	8 to 10 cu. ft.

To seal off small leaks, some 10,000 sacks of cement, largely with a 5 p.c. by weight of bentonite admixture, were placed inside the periphery of the Cofferdam cells.

#### WORKABILITY OF CONCRETES AND MORTARS.

Scripture.

Workability is one of the most important properties of concrete or mortar and without it, the potential value of other properties cannot be realized. The two factors which determine workability of concrete and mortar are mobility and cohesiveness. The requirements in concrete and mortar with respect to mobility and cohesiveness for different classes of work are discussed. Each concrete or mortar mix

should be fitted to the special purpose for which it is to be used by varying these properties in such a way that workability is not impaired. Workability varies with proportions of components in a mix, particularly with the proportion of water. The problem therefore is resolved largely into one of securing maximum workability with minimum water. The effect of different proportions of the various components of a mix on mobility and cohesiveness are discussed. A marked improvement in workability can be secured by careful design to give just the right proportions and size grading of each ingredient. It is also possible to effect substantial improvement in workability by the addition of certain auxiliary agents to the usual components of concrete. These agents include finely divided puzzolanic material, lime, clay, some fatty acid salt such as soap, electrolytes, colloids such as glue and tannin etc., and organic dispersing agents. Their effects on workability are discussed generally and a table is given showing the effect of the addition of such materials on mobility, cohesiveness, and strength of a mix.

#### CHECKING TORRENTIAL FLOODS.

Describes the progress of Los Angeles County Flood Control plan on which work was begun in 1914. The area involved is 2,800 square miles, and flood control works include detention dams, debris basins, channel improvements including straightening and lining of natural stream beds, and spreading grounds for getting the flood waters into underground basins. Fourteen storage dams have been built and another is nearing completion

#### CONTROLLED QUALITY IN ASPHALT PAVING.

Shattuck.

Gives the history of the development of asphalt paving in the city of Detroit 85 p.c. of whose roads are of asphalt. A description is given of the present equipment of asphalt plant at Detroit and the paving methods employed are detailed. There is a laboratory to test rapidly all materials used in the manufacture of bituminous paving mixtures.

#### STEEL BAFFLES STOP SLIDING FILL.

Allen.

A road in the state of Indiana is cut in a hillside, half of the road resting on a bench cut in the hill and the other half on earth fill. The fill portion gave frequent trouble due to sliding. An ingenious method was adopted to arrest this

sliding. The arrangement consists of a number of anchor bars fixed to reinforced concrete anchorages at the extreme end of the road on the hill side. The bars run across the full width of the road and down the slope of the fill and hold in position a number of steel retainer plates spaced at 12 ft. centres along the slope of the fill. These plates are buried in the fill. Steel plate cones are provided for the anchor bars where they bend over the edge of the road bank and follow the slope. The construction methods are described in brief. The plates are covered with earth and are not visible on the slope. The slope was completed 3 years ago and still shows no signs of moving to any extent.

#### DESERT WATER TANKS.

Sykes.

Storage basins composed of gravel and sand confined behind small dams have been in use for more than a century to conserve water in the semi-arid regions of the south west. The dryness of the climate makes it difficult to conserve water in any type of open pond or reservoir. To meet these extreme conditions, water is stored in what are known as sand tanks. The sand tank is formed by a masonry dam built where the stream bed is confined within a rock-bound channel. The dam is well bonded into bed rock and the rock walls of the channel, the object being to intercept all water moving down as drainage. The streams carry a large amount of material which is deposited behind the dam, and it is in the voids of this deposited material, which consists of coarse gravel and sand, that water is stored. The percentage of voids is from 25 to 30 per cent. Evaporation losses are very much reduced and the water is kept free from contamination.

*No. 2—July 8, 1937.*

#### THE WEEK'S EVENTS.

The 40th annual convention of the American Society for testing materials was held in New York during the previous week. The technical report of the meeting covers subjects such as developments in steel, corrosion resistance, bituminous materials, paint, cement, concrete, masonry materials and timber.

#### COMMENT AND DISCUSSION.

##### CLOUDBURST FLOOD FORMULAS.

This is a letter from Mr. C. C. Inglis, India, to the Editor, Engineering News-Record on the Cloudburst Flood Formula evolved by Gutmann. (See page 52 of Bulletin No. 4 and page 155 of Bulletin No. 6).

**BRIDGE BUILDING FOLLOWS FLOOD.****Bowman.**

The floods of March 1936 swept out hundreds of bridges and damaged many more throughout New England. So many bridges were washed out because flood stages were higher than ever before and because more ice was present than in any previous high water. The majority of bridge losses were connected with the failure of old dams on the small streams. The lessons in better bridge building emphasized by these failures are being applied to the replacement bridges. Larger spans, higher vertical clearances, deeper foundations, more positive anchorage of superstructure to substructure are some of the features of the new bridges.

**FAST TUNNELLING CLINCHES SALE OF WATER.****MARL TUNNELLING METHODS.****Gibson.**

A tunnel has just been completed to provide additional water supply for Charleston. 1,000 men worked night and day and completed a 7 ft. tunnel through rock 18½ miles long in seven months. These two articles describe the progress of the work and give details of tunnelling methods adopted.

**MUNICIPAL SEWAGE IRRIGATION.****Mitchell.**

Following the abandonment of an overloaded sand filter sewage treatment plant in 1928, Vineland, U. S. A. a town of 8,000 people adopted sewage irrigation farming as a means of disposal. The soil is coarse sand well adapted for drainage but not suited to farming unless irrigated and fertilized. In this article are described the layout of the farm, the details of the distribution system, preparation of the land for farming, cropping system, and irrigation practice at the farm. Some experiments on crop production and use of fertilizers which were carried out at the farm are mentioned. The cost data of the farm installation are given and the operating costs. Experience has shown that sewage irrigation if properly conducted is not a menace to health, and is practical and economical.

**STRUCTURES TO CONTROL TORRENTS.****Cruse.**

This is in continuation of the article in the previous issue dealing with the flood control works of Los Angeles County, California. The County asked for Federal aid for flood control which was granted two years ago and was restricted to ten specific items of work. These ten projects are described in brief, and consist of two main classes of structures: (1) debris basins and dams at the mouths of mountain canyons with outlet channels leading to the main river channels (2) enlarged and improved channels for the Los Angeles River and its principal flood producing tributaries.

Some of the principal features of channel improvement works are described in greater detail. Many new bridges had to be built on the rivers where the improved channels ran through cities. Features of the construction work are also briefly outlined.

#### NEW EXPANSION JOINT PROVES GOOD.

Webb.

Trial of a new expansion joint for concrete pavements has given excellent results in New York. The new device is called the flexible dowel, and consists of bent dowels used with premolded filler with form plates which hold the dowels in position in the filler. Each dowel consists of two deformed steel bars and two form plates. The bars are bent to place one end in the upper portion of one slab and the other end in the lower portion of the adjacent slab. The vertical portion lies in a slot in the expansion joint filler. A pair of these bars is placed in alternate positions in the two slabs. The installation procedure is described.

#### FROM FIELD AND OFFICE.

##### DESIGN FOR STADIA ROD.

Dinsmoor.

A new design for a levelling rod is suggested herein.

#### CUT AND FILL VOLUME TOLD BY CHART.

Arnold.

Warner.

A simple chart is given from which volumes of earth which must be moved in making cuts or fills of trapezoidal section over level ground can be computed. An example is worked out showing the use of the chart.

#### NEW AIDS TO THE CONSTRUCTOR.

##### HIGHWAY EXPANSION STRIP.

Effective sealing against moisture and temperature changes, and reduced noise are advantages claimed for this new expansion strip for joints in concrete highways.

##### PILE PULLER.

A cable grip for use in pulling piles from 14 to 18 inches in diameter has been recently placed on the market.

*No. 3—July 15, 1937.*

#### ASPHALT PLANT WITH PRECISION CONTROL.

Proctor.

Shattuck.

Describes a new hot-mix asphalt plant recently installed in Detroit. Some of its special features are exact plant control of proportioning, mixing, and temperatures, and highly perfected uniformity of the mix. It is capable of turning out 80 tons of sheet asphalt mixture per hour. The process of storage and handling of the materials, preparation of the aggregate and other details about the functioning of the plant are given in detail.

## NEW RECORD IN POURING CONCRETE.

This article contains an account of the progress of concreting the foundations for the Grand Coulee Dam and outlines experiences of the contractors in preparing the east half of the river bottom for concrete. About half of the concrete in the foundation contract has been laid, and future placing of concrete is scheduled at 440,000 cu. yd. per month. Prior to excavation of the dam site some 200 holes were core drilled to an average depth of 225 ft. to test the nature of the overburden and the quality of the rock beneath. After the removal of the overburden, the operation of cleaning up of the bedrock which involved mostly handwork with pick and bar, was undertaken. The area of the concrete granite contract totalled 2,000,000 sq. ft. Mechanical placing of the concrete is described in brief. A new pumping plant for concrete cooling, consisting of horizontal grids of cooling pipes connected to headers which lead to supply mains through which river water is circulated, has been installed.

## A. S. T. M. CONVENTION AT NEW YORK.

A brief review of the 40th annual convention of the American Society of Testing Materials held in New York from June 28 to July 2, 1937. The significant papers and specification developments that were presented are summarized by materials. Steel, cement, and concrete were the materials of major interest. Subjects discussed include yield point of structural steel, impact tests, corrosion of metals, fatigue of metals, cast iron tests, paints, bituminous materials, cement and concrete, masonry materials, brick efflorescence, and timber. One of the papers presented in the concrete session was on plastic flow of concrete. In the field of concrete aggregates, two new specifications were proposed and adopted. One of these is of light weight aggregate for concrete and the second covers a tentative method of test for abrasion of coarse aggregate by the use of the Los Angeles abrasion machine.

## RUSTPROOFING FORT PECK PENSTOCK.

The four outlet tunnels for Fort Peck Dam are steel lined. In one of the tunnels, the steel lining is protected by a coating of coal tar enamel for a distance of 3,118 ft. downstream from the control gate shaft. The plant and procedure employed in applying the protective coating are briefly described.

*No. 4—July 22, 1937.*

River aqueduct distribution system 35 miles east of Los Angeles. Ground surface subsidence along a 2 mile length of the Colorado Ground Subsides on 2-Mile Line.

Angeles has been observed during the past  $3\frac{1}{2}$  years. In this period the ground surface has subsided by about 1 ft. The subsidence was detected as the result of periodical check of bench marks along the aqueduct line. The city engineer of La Verne which is situated in the area of subsidence is of opinion that the subsidence is the result of groundwater lowering, following which the alluvial soil material has compacted and settled during the drying out process. Water levels in this locality have dropped 100 ft. in 10 years.

#### MISSOURI RIVER BLOCKED AT FORT PECK.

Chorpening.

The Missouri River at Fort Peck Dam has been diverted through four concrete lined tunnels for the completion of the Fort Peck Dam. The dam which is in course of construction is an earthen dam nearly 4 miles long of which the main section of 9,000 ft. lies in the valley proper of the river. The main section has a base width of 3,000 ft. and a maximum height of 242 ft. The dam was being built in two sections, one on each side of the river leaving a gap in the middle for the stream. On the completion of the tunnels the stream has now been diverted through them and the gap is being closed. The gap was 800 ft. wide and a railway bridge was constructed across it mainly for the transport of materials to the spillway. It was planned to close the opening by dumping material from the railway bridge on the upstream side but two days before the date fixed for the closure operations a slide of the fill on one bank of the gap occurred, endangering the safety of one pier of the railway bridge. The slide was on the downstream side of the bridge. Plans of closure operations were therefore changed and closure was started immediately by dumping rock and gravel from the railway bridge around the threatened pier and along the toe of the slide. Fleets of bull-dozers pushed the gravel into the stream from either bank of the gap and a derrick boat was engaged in building up a rock sill to hold the gravel in place against the current of the stream. The operations are described in details.

*No. 5—July 29, 1937.*

#### THE WEEK'S EVENTS.

##### BEDROCK REACHED AT PARKER DAM.

Bedrock was reached at Parker Dam site in what is stated to be the deepest excavation for the foundation of a dam, 230 ft. below the river bed. The Parker Dam will be of concrete arch type and will regulate the flow of Colorado River below Boulder Dam. It is 155 miles below Boulder Dam on the Colorado River.



### SAN GABRIEL DAM COMPLETED.

San Gabriel Dam of the Los Angeles Flood Control District is a rockfill structure 355 ft. high, 1,670 ft. long at crest and 2,000 ft. thick at the base. It is the highest dam of this type ever built. The upstream and downstream slopes were originally proposed as  $1\frac{1}{2}$  to 1 but owing to the unsatisfactory nature of the available rock material, the slopes were finally altered to 3:1. The cross section of the dam was divided into zones comprising a core of mechanically compacted quarried material, a clay-sand zone upstream of the core and a zone of quarried material on the extreme upstream side. On the downstream side, quarried material was placed grading from fine to porous on the extreme downstream side.

### COMMENT AND DISCUSSION.

#### CROWN FORMULA FOR ROADS.

The writer has given another formula which he has been using for the past twenty years which gives the shape of the crown of the road, and is different from the formula given in the original article published in June 17, 1937 number of the Engineering News-Record.

### BOULDER DAM EARTHQUAKES CONTINUE.

Earthquakes at Boulder Dam continued through the first half of 1937. No damage is reported but the frequency of shocks now occurring where none were reported before the completion of the dam has given rise to much speculation as to whether the cause lies in the extra load on the earth's crust imposed by Lake Mead. The U. S. Coast and Geodetic Survey have installed three instruments in or near Boulder Dam to record the earthquakes and two more instruments are to be installed one on either side of Lake Mead.

### PLASTIC FLOW IN CONCRETE.

Davis.  
Davis.  
Brown.

"The purpose of this paper is to present the results of some of the investigations made at the University of California, all having to do with volume changes of concrete, and to point out the possible significance to design and construction problems of volume changes under the action of sustained load referred to as plastic flow".

The investigations were started in 1926 and comprise to date some 25 series of tests. The earlier series include studies to determine the effect upon plastic flow under sustained compressive stress, of (1) duration of loading (2) moisture and temperature conditions of storage (3) moisture content of concrete (4) gradation and character of aggregate (5) size of mass (6) age at time of loading and (7) reinforcement.

The more recent studies were for the determination of effect of water cement ratio and aggregate cement ratio upon plastic flow, the effect of fineness and composition of cement upon plastic flow, plastic flow in tension and compression, strains in plain concrete beams under constant sustained bending moments, and stresses developed in large concrete cylinders during a heating and cooling cycle, similar to that which will occur in mass concrete. The results of some of the studies are discussed. One important result refers to observations of plastic flow of ordinary portland and low heat Portland cements. It was found that concrete with low heat cement exhibited the largest plastic flow. Differences in degree of cracking of mass concrete structures is considered to be due to differences in plastic flow characteristics of the concretes forming the structures. In the construction of Morris Dam a modern low heat cement was used with the result that the structure is generally free from cracks. Another result indicates the existence of high stresses due to heating and cooling in mass structures. In the case of dams these stresses combined with the load may produce a stress system entirely different from that calculated by the usual methods which ignore the effect of thermal changes. Structural cracks in dams where contraction joints were provided point to the correctness of the above argument.

#### **THIN-CORE HIGH EARTH DAM.**

Strange.

The Ralston Creek Dam is being built about 20 miles to the north of Denver, U. S. A. The reservoir created will serve as a storage and distribution reservoir for the city of Denver. The dam is 1,150 ft. long at crest, 200 ft. high and has a base width of 945 ft. It consists of a central core section of selected clay, sand and gravel, moistened and thoroughly compacted by sheepsfoot rollers. The upstream section adjoining the core section is compacted sand and gravel and the downstream section is sand gravel and cobble with a heavy rockfill at the toe. There are 4 cut-off trenches 20 ft. wide excavated 8 ft. into the shale foundations under the impervious core section. These trenches are carried across the base of the dam up both abutments.

The Central core is built up in 6 inch layers, and the material from the pit contains 16 per cent. moisture. Construction of the tunnel and spillway is briefly described.

#### **FLOOD "SAND BOILS" ANALYSED AT CAIRO.**

Sand boils near levees frequently occur during high floods. The Superintendent of the Cairo Water Company in a paper read before the American Waterworks Association states that these boils are ordinary springs which flow only during periods when the normal sub-soil flow to and with the rivers is restricted. Contrary to popular belief this spring water does not come from the river.

Permanent treatment of sand boils does not present difficulties. The treatment consists of filling underground cavities with cement grout, forcing it down with compressed air, and spreading a blanket of clay over the affected area to raise the surface elevation to a point above which the ground water will not rise.

#### THE WEEK'S EVENTS.

A proposal has been made to make a five mile cut-off across a 22 mile river bed immediately below New Orleans on the Mississippi. The cut off would reduce flood stages at New Orleans and provide a shorter sailing distance for steamships using the port of New Orleans.

*No. 6—August 5, 1937.*

#### BRICK SCHOOL BUILT EARTHQUAKE-RESISTANT.

Fork.

Reinforced brickwork construction has been adapted to meet the new and more stringent laws on earthquake resistance in a school building at Los Angeles. The structure has walls of reinforced brick masonry with floors and roofs of reinforced concrete. California's laws on earthquake resistant buildings require that in addition to all requirements for gravity loads, the structure must be able to resist 10 per cent. of these loads applied to the building laterally in any direction. Some special features of the brickwork construction are the use of specially shaped brick or brick units to provide channels for grout around the reinforcement and the development of a technique for filling the interior joints with grout. The different types of specially shaped bricks used are described, and the arrangement and use of these units are explained. The method of placing the cement grout between the joints is described. Mortar proportions used are given. The internal and external walls with roof and floor slabs form a rigid frame capable of resisting horizontal forces from any direction.

#### THE WEEK'S EVENTS.

##### EXTRA WATER DEMAND FOR AIR CONDITIONING.

The increasing use of air conditioning apparatus in the United States with a resulting demand for increasingly large quantities of water is a matter of growing concern. Installations of air conditioning apparatus have increased 1,400 per cent. from 1933 to the end of 1936.

#### SPILLWAY CHANGES MADE AT HORSE MESA DAM.

Major changes are being made in the spillway of the Horse Mesa Dam on the Salt River in Arizona as a result of 10 years experience. Flow from six gates totalling 67,000 sec. ft. at full opening was discharged directly down the canyon wall to the river 210 ft. below. A lip has now been added to the spillway so that the overflow is thrown clear of the canyon wall.

No. 7—August 12, 1937.

## COMMENT AND DISCUSSION.

### BEAM DEFLECTION.

Mr. Fleming in a letter says that the problem of finding deflexion of a beam is a very difficult one, and calls attention to two recent text books in which the subject has been discussed. Prof. Boyd, the author of several well known text books thinks that three methods are all that are worth while. These are :—the classical successive integration method, between limits; area moments method which is geometrical; and the elastic energy method which is dynamical. Mr. Drucker in another letter gives a method due to Prof. Witmer which he considers the simplest and most automatic to use. He discusses an actual example of a continuous beam to illustrate the use of the method.

### TWIN TIED ARCHES FOR BALTIMORE BRIDGE.

Schroedl.

A 55 year old pin connected truss bridge in Baltimore has recently been replaced by a modern steel tied arch structure on the old foundations. Considerations leading to the choice of this particular type of structure are discussed. The principal features of the design of the arches with the rigid top laterals connecting the two arch ribs at either end of the roadway are given. The roadway deck is made of welded interlocking steel channels, plug welded to the tops of the track and roadway stringers. The roadway is 40 ft. wide, accommodating two electric railway tracks.

### FLOOD CONTROL BY RESERVOIRS.

Morgan.

The floods of January-February 1937 have again brought into prominence the question of flood control in the Ohio Valley and the lower Mississippi. The actual flood heights and the flood discharges measured show that the system of protection under the Jadwin Plan is inadequate. The levees were tested to the practical limits of their capacity even though the flow did not reach the maximum allowed for under the plan. Levees alone are therefore not enough. On account of foundation difficulties, seepage, wave wash and kindred problems, it does not appear feasible to increase the height of the levee system throughout its length sufficiently to provide protection against maximum floods. Levees will continue to be necessary and play a dominant part for maximum protection but they cannot be relied upon to do the job alone, and must have help. The most promising help available is reservoir control. Effective reservoir control for the Mississippi Valley should include reservoirs located on the Ohio itself and its principal tributaries as far down on each stream as possible. The futility of controlling maximum floods in the valleys by head water reservoirs is evident to anyone

who studies the 1937 floods and the distribution of the rainfall which caused it. The rainfall was intense in the lower and middle reaches of the Ohio River and its tributaries, and was light on the headwaters. .

Two reservoir projects have recently been investigated by the Tennessee Valley Authority comprising reservoirs on the Ohio and the Tennessee Rivers. These are described and the points in favour of each of these projects are discussed. Of the two projects, one involving the construction of a dam on the Ohio River and another on the Tennessee River is considered to be the better. Flood control benefits of this project will extend throughout the greater part of the lower Mississippi valley. Other incidental benefits of the project to navigation, power development, reduced costs of levee maintenance, etc., are discussed.

Other reservoirs which have been completed, are under construction, or are being planned on the Ohio River and its tributaries, and which will have beneficial effect on the flood problem are mentioned. The importance of proper operation of a reservoir system for the control of floods is emphasized. The greatest benefit would be expected from a few large projects rather than from many small ones.

#### RETAINING WALL DESIGN.

Menuez.

Two formulae are derived from which the base width of gravity retaining walls can be found if the values of top width and the height are given.

*No. 8—August 19, 1937.*

#### DESERT MENACE IN THE SAN JOAQUIN.

The Central Valley of California consists of the basins of the Sacramento and San Joaquin rivers which meet in the middle of the State and flow to the San Francisco Bay. Rainfall is heavy in this tract, but it receives little or no rain during a large part of the growing season. In the Sacramento valley, irrigation from the rivers is practised and is adequate for the requirements. In the San Joaquin Valley river water was scarce and ground-water was used for irrigation. But the agricultural development in San Joaquin valley went on without reference to the available water resources so that more area was developed than that for which a reasonable supply of water was available. A few dry seasons resulted in lowering of ground water level by a very large amount with the result that 50,000 acres of highly developed land were threatened with desert conditions. To save this land from the desert menace the Central Valley Project has been conceived. The scheme consists of a reservoir on the Sacramento River which will store previously wasted flood water. This water will be released into the Sacramento River whence it will be

lifted into the San Joaquin valley *via* a canalized portion of the river and a supplementary canal system by a series of pumping plants. The water will thus be taken uphill to a tract 300 miles away. Power will be produced at the dam as a by-product.

#### BEACH EROSION STUDIES TO BE MADE IN WAVE TANK.

Describes a new 27,000 gal. wave tank being built by the Beach Erosion Board for the study of wave action on beaches.

#### EVANSVILLE TRANSFORMS ITS RIVERFRONT. Geupel.

An unsightly and neglected waterfront of a city on the Ohio River has been reclaimed. The various features of the works are a riverfront boulevard, a concrete wharf, a new levee and promenade extending over a mile along the river bank protected by riprap and a recessed basin for pleasure boats. Details of the various works are described and the effect of the 1937 floods on them are discussed.

#### FORECASTING MOUNTAIN WATER SUPPLY BY PHOTO- GRAPHING SNOWFALL. Gross.

An original method of forecasting run-off from accumulated snowfall is being developed at Denver. Pictures of snow distribution are taken at regular intervals and correlated with run-off data from the watershed. The method is briefly described.

#### NEW YORK'S NEW BUILDING CODE. Strehan.

The history of the development of the new Code is outlined, the new code is compared with the old one, and the new regulations are critically analyzed.

#### NEWS OF THE WEEK.

Sub-Committees of the National Research Council have been set up to study density currents in Lake Mead and the Elephant Butte reservoir, and a programme of field observations on the flow of silty waters through these reservoirs is being formulated.

*No. 9—August 26, 1937.*

#### THE WEEK'S EVENTS.

As a result of not carrying the reinforcing steel in the deck slab of the George Westinghouse concrete arch bridge at Pittsburgh near enough to the face of the expansion joints, cracks have developed in the slab. Repairs will consist of placing structural steel shelf angles under the ends of the slabs at the expansion joints.

# CALIFORNIA'S LONG-RANGE WATER PLAN.

Describes features of the Central Valley Project. The Kennett Dam on the upper Sacramento River will store water which will be pumped up to the San Joaquin River Valley. The major engineering features of the project are—

- (1) Kennett Dam forming a large storage reservoir on the upper Sacramento river from which a regulated flow will be maintained down the river channel.
- (2) Contra Costa Canal, a channel with pumping plants to carry water from the delta into the upper San Francisco Bay area.
- (3) A series of pumping plants along the San Joaquin River to transport Sacramento River water upstream from the delta to the upper parts of the San Joaquin Valley.
- (4) Friant Dam which will form a supplemental reservoir on the upper San Joaquin River for the supply of canal systems leading therefrom to the south San Joaquin Valley.

Details of the two dams and the canal systems are given. The Kennett dam will be a concrete gravity structure over 400 ft. high and the Friant dam is also to be a concrete gravity structure about 250 ft. high, and 3,380 ft. long.

In the Southern San Joaquin Valley an underground storage of 20,000,000 acre ft. within feasible pumping range is available for extraction. Utilization of this storage capacity in conjunction with surface storage is considered essential to meet the water requirements of the present irrigated area.

## FINDING WEAK SPOTS IN BRIDGES.

Berhard.

As an advance on static and moving load tests, European engineers have developed a method whereby induced vibration is applied to bridges as a means of locating defects, specially of welded structures. The equipment used and the procedure are described.

## FIVE CLASSES OF FILL IN LARGE DAM.

Jacobs.

Describes details of construction operations of a rock and earth fill dam being built on the Warrior River, 35 miles from Birmingham, Ala., U. S. A. The dam is 1,100 ft. long

and 195 ft. high and consists of 5 classes of fill excluding rip-rap on the upstream face. These are clay, crushed rock 3" diameter and under, 3" to 15" diameter quarry rock, and  $\frac{1}{2}$  inch diameter crushed rock screenings. Details of the crushing and screening plant used are given, and the construction of outlet and diversion tunnels and the spillway are described.

## THE HIGHWAY MAGAZINE.

*April 1937.*

### ROADBED STABILIZATION BY DRAINAGE.

Cotton.

The importance of removal of free water by drainage from the vicinity of roads is emphasized, and free water conditions actually met with in practice are discussed with suggestions for dealing with them.

## THE MINES MAGAZINE.

VOL. 27.

*No. 2—February 1937.*

### MAPPING THE BRAZOS RIVER OF TEXAS.

Fenton.

The Brazos River conservation and Reclamation District is an organisation established in 1934 with the object of controlling the floods of the Brazos River in Texas, U. S. A. The objectives of this organization are mainly flood control and reclamation of flooded lands. The scheme comprises thirteen dams on the main river and its important tributaries, with a number of small dams on the headwaters of smaller tributary streams. The surveys and mapping of these reservoir areas were carried out by aerial methods and these methods are described in detail in this article. The aerial survey methods of mapping consist of taking aerial photographs from an aeroplane and stereoscopic plotting. The plotting machine and its working are described and the various stages in the preparation of a complete map are set forth.



# PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

Vol. 63.

No. 6—June 1937.

## EFFECT OF DOWEL-BAR MISALIGNMENT ACROSS CONCRETE PAVEMENT JOINTS.

Smith.  
Benham.

The subject of joints in concrete pavements to provide for expansion and contraction and the means of transferring loads across joints is important in highway construction. Dowel bars passing through the joint and embedded in the two adjacent slabs are generally used. It is necessary to install the dowel bars correctly perpendicular to the cross section of the pavement failing which they will not slip freely in the concrete. This paper describes an investigation to determine the accuracy with which the dowel bars were being installed in a particular work and another investigation which was conducted to determine by experiment the degree of precision necessary to assure satisfactory functioning of the joints.

## ESSENTIAL CONSIDERATIONS IN THE STABILIZATION OF SOIL.

Hogentogler.  
Willis.

The underlying principles involved in soil stabilization are discussed in this paper and possible means of soil stabilization are investigated. Design requirements of stable soil mixtures are laid down. Stabilizing action of various types of admixtures is described and details are given of experimental work with various admixtures and the results. The admixtures include Portland Cement, bituminous materials, waste sulphite liquor, molasses residues, calcium humates, and calcium silicate. A method is described of utilizing electricity for stabilizing soils. Tests used in soil stabilization are outlined. In conclusion, the author reviews the development of soil stabilization up to the present time and gives his conclusions in the light of the present knowledge.

## SOIL REACTIONS IN RELATION TO FOUNDATIONS ON PILES.

Miller.

This paper is an attempt to correlate the collected data on pile foundations under varying soil conditions so as to discover reasons for success and failure. Records collated from 250 pile driving projects well distributed over the United States form the basis of this paper. The paper deals with bearing values of pile foundations in different soils,

the behaviour of pervious and impervious soils, skin friction, load carrying capacity and static load tests, and spacing of piles. Some actual cases of pile foundation settlements are described and the causes of settlement are discussed. In conclusion, the author makes some recommendations which should be carried out to ensure satisfactory results.

DISCUSSIONS ON THE FOLLOWING PAPERS APPEAR IN THE ABOVE ISSUE OF THE PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

SIMPLIFIED METHOD OF DETERMINING TRUE BEARINGS OF A LINE.  
ECONOMIC DIAMETER OF STEEL PENSTOCKS.

STRESSES AROUND CIRCULAR HOLES IN DAMS AND BUTTRESSES.

GRAPHICAL DISTRIBUTION OF VERTICAL PRESSURE BENEATH FOUNDATIONS.

RAINFALL INTENSITIES AND FREQUENCIES.

FLOW CHARACTERISTICS IN ELBOW DRAFT-TUBES.

ECONOMICS OF HIGHWAY-BRIDGE FLOORINGS OF VARIOUS UNIT WEIGHTS.

NATIONAL ASPECTS OF FLOOD CONTROL : A SYMPOSIUM.

THE PASSAGE OF TURBID WATER THROUGH LAKE MEAD.

## THE RECLAMATION ERA.

VOL. 27.

*No. 6—June 1937.*

### THIRTY-FIVE YEARS OF DAM CONSTRUCTION.

Swanton.

The Reclamation Act was passed in 1902 and since then the programme of the Bureau of Reclamation has thus far involved the construction of 160 storage and diversion dams in addition to which 19 dams are in progress at the present time. Brief accounts are given of some of the more important dams such as the Elephant Butte Dam, the Boulder Dam, and the Grand Coulee Dam, and some important features of these dams are mentioned. A list is given of the dams exceeding 50 ft. in height built by the Bureau of Reclamation.

### INTERESTING CONSTRUCTION AT HORSE MESA DAM.

Larsen.

The Horse Mesa Dam on the Salt River in Arizona was completed in 1927 but soon after completion a number of

undesirable conditions became apparent with the operation of the dam and power plant. The most important of these was the discovery that the spillways though designed for a discharge of 150,000 cusecs, discharged only 90,000 cusecs. When discharging, the water from the spillways flowed down the short aprons, and striking the rocks near the bottom of the Canyon was deflected in such a manner as to drench the substation on the top of the power house. It was therefore decided to build an auxiliary spillway tunnel around the north abutment of the dam. Laboratory tests on models indicated that the discharge capacity of the spillways could be increased by constructing new ogee aprons on the downstream side of the crests. This would also remove the objectionable conditions near the power house, and the water from the spillway would leap clear of the Canyon wall and drop directly on the river bed.

Some of the difficult and trying features of the job are described which includes, besides the tunnel and the spillway mentioned above, filling of a large cave near one of the abutments, a spiral stairway on the vertical downstream face of the dam, and a suspension footbridge.

The Horse Mesa Dam is a plain concrete structure of the variable radius arch type 305 ft. high and 784 ft. long with a base width of 57 ft.

*No. 7—July 1937.*

#### CONSTRUCTION OF RYE PATCH DAM.

Foster.

The Humboldt project of which the Rye Patch Dam is the principal feature is located in Western Central Nevada on the Humboldt River. The Rye Patch Dam is of the straight earth fill type having a maximum height of 80 ft. and a length of 800 ft. The base thickness is 505 ft. The upstream face has a slope of 5 to 1 and the downstream face a slope of 2 to 1. Both upstream and downstream faces are covered with a gravel blanket. The dam is keyed into the foundation by 4 cut-off trenches, one of which is the main cut-off trench and three are subsidiary trenches. The main cut-off trench is located 80 ft. upstream of the axis of the dam. A wall of steel sheet interlocking piling is driven through the sand stratum across the river bottom into the clay stratum below in the main cut-off trench. The earthfill of the embankment was rolled by mechanical rollers.

The spillway is of the overflow type and is of reinforced concrete. The outlet works consist of a circular tunnel 462 ft. long and 12 ft. in diameter.

**THE NOXIOUS WEED CONTROL PROGRAM ON THE  
SHOSHONE PROJECT, WYOMING.**

Corkins.

Describes some weed control and eradication methods and mechanisms successfully used in Wyoming.

**C. C. C. EROSION AND FLOOD CONTROL PROGRAM,  
RIO GRANDE PROJECT.**

Mealey.

Describes some works carried out by the Civilian Conservation Corps in the Rio Grande Valley for erosion and flood control. These include masonry dams, check dams, and contour terracing.

*No. 8—August 1937.*

**THE PROGRAM AND OBJECTIVES OF THE RECLAMATION  
BUREAU.**

Stoutemyer.

Describes some of the objectives of the Bureau of Reclamation which include flood control, improvement of navigation, and power generation.

**CONSTRUCTION OF PINE VIEW DAM, OGDEN RIVER  
PROJECT.**

Imrie.

A history of the project is given and the objects to be served by the project are mentioned.

The main feature of the project is the Pine View Dam constructed across the Ogden River in Utah. The dam is an earth and rock fill structure with a maximum height of 102 ft., and a length of 500 ft. A cross section of the dam showing the materials used in the various parts of the dam is given. A cut-off trench with sheet piling driven to bedrock is provided.

Details of diversion tunnel, spillway, and foundation conditions and operations are given.

**EIGHT THOUSAND MILES OF RECLAMATION PROJECTS.**

Smith.

Describes a tour of inspection covering twenty reclamation projects and including 35 dams in all stages of construction. Some important features of a few projects are briefly mentioned.

**SCIENCE.**

**VOL. 84.**

*No. 2167--July 10, 1936.*

**THE EFFECT OF IRRIGATION UPON SOIL TEXTURE.**

The effect of irrigation upon soil texture has been noted in the Salt River Valley, Arizona. A soil survey of certain

areas was made in 1899 and another in 1927. There are great differences in the results which clearly indicate a change in the characters of the soils. These changes are described and are attributed to irrigation, which has produced clay loams and clays out of sandy loams. The Salt River water used for irrigation has 300 to 500 parts per million of total salinity in floods, and 1,500 parts per million in low flow. The use of water of this high salinity has hastened the soil disintegration. Two results of this change are important. First, the increase in clay content has made penetration of irrigation water very slow which causes an accumulation of salinity in the soil. The second effect is the liberation of soluble matter within the soil which may have a damaging effect on it.

## JOURNAL OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

VOL. 10.

*No. 3—August 1937.*

### INFLUENCE OF RICE FIELDS ON LOCAL HUMIDITY AND TIME OF DEW DEPOSITION.

West.  
Mallaby.

This paper presents results of investigations to determine the effect of rice fields on humidity and time of dew deposition in neighbouring areas. It has been found that rice fields cause slight decrease in temperature and increase in both relative and absolute humidity during day time, and increase in humidity and an earlier deposition of dew at night. The influence is however in-appreciable beyond the distance of 2 chains from the rice field.

## JOURNAL OF THE INSTITUTION OF ENGINEERS, AUSTRALIA.

VOL. 9.

*No. 6—June 1937.*

Nothing of interest to irrigation engineers in this issue.

*No. 7—July 1937.*

### DISCUSSIONS AND COMMUNICATIONS.

#### THE INFLUENCE OF AREA-SHAPE ON RUN-OFF.

Hawken.

The author of the original paper which was published in December 1935 issue of the journal replies to the various comments on his paper.

**RIVER FLOOD MEASUREMENT FROM HEIGHT RECORDS.****Hawken.**

Comments by Mr. Kemp on the above paper published in the August 1936 issue of the journal, with the reply of the author of the original paper.

**PUBLICATIONS OF VARIOUS GOVTS., INSTITUTIONS,  
SOCIETIES, ETC.**

**ENGLAND.***Ministry of Transport and Ministry of Agriculture and Fisheries.*

**JOINT COMMITTEE ON DAMAGE TO FISHERIES :  
DETAILED BIOLOGICAL AND CHEMICAL REPORTS  
ON TARS USED FOR ROAD-SURFACING.**

The Committee was appointed in 1920 to investigate the question of the alleged pollution of streams by drainage from tarred roads. Results of investigations are presented in this report.

*Institution of Civil Engineers.***MINUTES OF PROCEEDINGS, 1934-35, VOL. 240.**

**CONSTRUCTIONAL ENGINEERING WORK IN THE NEW  
DUNSTON POWER STATION FOR THE NORTH-  
EASTERN ELECTRIC SUPPLY COMPANY LTD.**

**Anderson.**

The site of the power station being poor as regards foundations, it was decided to adopt reinforced concrete pile foundations. The reinforced concrete piles were 14 inch square ranging in length from 25 feet to 50 ft. The concrete mix of the piles was one part of Portland cement, one part of clean coarse sharp sand from 3/16 inch gauge downwards and two parts of aggregate passing through a 1½ inch square mesh but retained by a 3/16 mesh. The piles were driven by drop hammer 70 cwt. in weight and of the single acting type. Details of reinforcement of the piles are given, and pile driving operations are described. Some important features of the construction of the turbine house, boiler houses and other appurtenant structures are given.

**SPEED IN RELATION TO CURVATURE, WITH SPECIAL  
REFERENCE TO ROAD-CURVES.**

**Royal-Dawson.**

A study of the relationship of speed and curvature on a highway is presented in this paper. Transition curves are discussed and working formulas are given for the design of curves. Superelevation and the method of its application to transition curves are discussed and a method of calculating superelevation is given.

**ASPECTS OF HIGH-WAY-CURVE DESIGN.****Criswell.**

An article on the design of road curves. An analysis of various forms of transition curves is given, vertical curves are discussed and a number of tables are attached which are of great help in the design of road curves.

**THE ISKANDAR BRIDGE, PERAK, FEDERATED MALAY STATES.****Coales.  
Clarkson.**

Describes the design and main features of construction of a bridge consisting of 7 spans of two hinged steel arches, the largest span being 160 ft. at the centre and decreasing to 150 ft., 130 ft., and 104 ft. respectively towards each end. The abutments and piers are founded on mass concrete caissons and the work in the foundations is described in detail.

**THE NEW KHEDIVE ISMAIL BRIDGE, CAIRO, EGYPT.****Stephen.**

The new bridge was erected at the site of an old lattice girder bridge which was dismantled. The dismantling operations are described. The new bridge is a girder bridge with a reinforced concrete deck slab consisting of two shore spans of 43.1 metres, four fixed spans of 50.00 metres and two swing spans of 48 metres. The abutments and piers are founded on reinforced concrete caissons. Details of the caissons and steel work are given and the swing span with its operating mechanism is described at length. Construction operations are described in detail.

**REMEDIAL MEASURES ON THE ARAPUNI HYDRO-ELECTRIC SCHEME OF POWER DEVELOPMENT ON THE WAIKATO RIVER, NEW ZEALAND.****Furkert.**

This paper deals with the remedial measures carried out in connection with the Arapuni Hydroelectric Power Development installation in New Zealand after the occurrence of a crack in the rock under the head race. The trouble at the works included seepage through the rock underlying the dam, erosion of rock at the spillway falls and a crack in the rock which occurred when the reservoir behind the dam was filled up. The remedial measures included concreting of the spillway falls, lining of the head race and grouting and dowelling in the vicinity of the dam. An account is given of the damages in the sequence of their occurrence and the carrying out of the remedial measures are described in detail.

## THE PYKARA HYDRO-ELECTRIC DEVELOPMENT.

Platts.

Describes the design and construction of the Pykara Hydro-Electric Scheme in the Madras Presidency. Rainfall and run-off are discussed in detail and it is shown how the storage capacities were arrived at. The works include the Glen Morgan Dam and two earthen bunds at the upper and lower end. The dam is of random rubble masonry and is 50 ft. high. Some details are given of the construction operations. The power house, its machinery and equipment are also described.

## THE LAWS OF A MASS OF CLAY UNDER PRESSURE.

Ravenor.

This paper presents the results of a study of the problem of a large mass of clay subjected to the pressure of a finite area. The author has conducted a large number of tests in the field, and has been able to reconcile his tests with the actual settlement of structures erected in the same clay. The laws that have been deduced from a rational interpretation of the tests confirm experiments made by other investigators. The author has enunciated a law of induration, that is, the behaviour of clay during its ductile stage. The author's investigations show that clay is not a homogeneous material as assumed by Rankine. He describes the apparatus used by him in his tests and discusses the results of his experiments. He has derived an equation relating load and settlement based on his experiments.

*The Royal Society.*

PROCEEDINGS OF THE ROYAL SOCIETY, SERIES A,  
MATHEMATICAL AND PHYSICAL SCIENCES, No.  
892, 2ND DECEMBER 1936, VOL. 157.

THE FORCES ON A CIRCULAR CYLINDER SUBMERGED  
IN A UNIFORM STREAM.

Havelock.

A solution is given in this paper for the two dimensional wave motion due to a circular cylinder in a uniform stream, taking fully into account the condition at the surface of the cylinder.

FLUID FRICTION BETWEEN ROTATING CYLINDERS.  
I. TORQUE MEASUREMENTS.

Taylor.

Results of certain experiments carried out with the object of measuring the torque between concentric rotating cylinders with fluid in between are given in this paper.



**II. DISTRIBUTION OF VELOCITY BETWEEN CONCENTRIC CYLINDERS WHEN OUTER ONE IS ROTATING AND INNER ONE IS AT REST.**

**Taylor.**

Describes certain experiments carried out to measure the distribution of velocity under the conditions stated and gives results obtained.

**THE MOVEMENT OF DESERT SAND.**

**Bagnold.**

Experiments on the motion of sand grains and their reaction on the air stream when wind blew over a thick uniform layer of sand were carried out in a wind tunnel devised by the author. These experiments are described in this article. The paths of individual grains were photographed. Total mass flow of sand past various sections of the tunnel were measured directly. The wind velocity distribution in the tunnel was also measured.

**HUNGARY.**

**ANNUAL REPORT OF THE HYDROGRAPHIC INSTITUTE OF THE ROYAL HUNGARIAN MINISTRY OF AGRICULTURE, 1935.** [With an abridged report (in English) on the activities of the Hungarian Hydrographic Institute from 1886—1936]. (In Magyar.)

**Laszloffy.**

**SITUATION PLAN, PROFILES, AND CROSS SECTIONS OF THE TISZA RIVER.** (In Magyar.)

These two publications record the work done on Hydrology in Hungary during the last fifty years. The volume of plans is extraordinarily fine and although references are in Magyar, notes in English enable the plans to be understood.

“The Tisza river is noticeable for three reasons: (1) On account of its exceptionally small slope 0·00001—0·00005, it has special peculiarities from the point of view of hydraulics and hydrology. (2) Much may be learned from the radical regulations carried out upon the river—the length of its lower reach has been reduced by 112 cut-offs from 700 to 435 miles, i.e., by 38 per cent. (3) The greatest flood-controlling work in Europe has been done within its basin—2,200 miles of levees, 6·4 million acres of protected areas”.

The immense amount of work done during the last fifty years, as described in these publications, makes one wonder how much similar information is available regarding such rivers as the Ganges in India. The English summary states:—“The improvement of regulation and the prevention of flood catastrophies was rendered possible only by a systematic study of the nature of the river”.

The following is extracted from the abridged report :—"Hydrometry in this country to a certain extent developed in a special way. As our rivers have small velocity and copious discharge, and carry very fine material, we were compelled to adjust instruments and methods of measuring to these conditions. In rivers of small velocity only easily-revolving current meters could be employed, and their bearings had to be constructed so that the fine silt in suspension should constantly be rinsed out of them. The current meter constructed by S. Hajos answered these demands; it has been used in this country, and was introduced into Russia before the war, and recently also into Czechoslovakia and Yugoslavia. It was necessary to find out a quick method of survey for cross-sections, more than a thousand feet wide and 30--70 feet deep, without diminishing the accuracy of results. In 1897 Samuel Hajos employed the so-called differential method, which is simply an improved variation of the integrating method. The essence of the differential method is that the current meter is lowered with uniform speed from the water surface to the bottom and meanwhile every turn of the wheel is marked on a slip of paper in the function of the water depth and the time. From the data obtained in this way, the curve of velocities in a vertical line can be drawn and completed down to the bottom. The current meters are rated according to a method proposed by S. Hajos by drawing the instrument in still water with gradually increasing, then decreasing speed. By this method the process of rating can be accomplished in a short time".

#### ITALY.

##### ANNUAL REPORT ON HYDROLOGY 1933 : PART II— DATA. (In Italian.).

This publication records the hydrological studies in Italy for the year 1933. Details of all gauging stations and methods employed are given.

#### RUSSIA.

*Academy of Sciences in the U. S. S. R., 1936, Vol. III (XII), No. 4(99).*

##### THE INFLUENCE OF CAPILLARITY OF SOIL FILTRATION WITH FREE SURFACE.

Vedernikov.

Describes the various forces governing the movement of water in the groundwater and capillary zones. The author concludes that the movement of water in the capillary zone

and in the groundwater zone is a single indivisible movement obedient to various normal forces, and says that the movement of water in the capillary zone is distinguishable from that in the groundwater zone by means of the atmospheric pressure and by a diminution of the speed of filtration in ratio to the changes in humidity and pressure along the level or height of the zone.

## SWEDEN.

### *Royal Swedish Institute for Engineering Research.*

#### ON VELOCITY FORMULAS FOR OPEN CHANNELS AND PIPES.

Lindquist.

The object of this publication is to bring together in a single compilation the different formulae used in various countries for velocities in pipes and open channels. In the first place the empirical formulas for open channels in use at the present day are discussed and the origin of the formulae is traced. These include the Chezy formula, Lameyer's, Humphrey-Abbott's, Darcy-Bazin's, Ganguillet-Kutter's and Manning's formula. The author then discusses the empirical formulae used for pipes and outlines their development.

Summarizing his review of the various empirical and theoretical formulae on flow of water in pipes and open channels the author says that two theoretical formulae have been developed by Von Karman and Prandtl for computing the velocity in pipes with smooth and rough walls. These formulae being too complicated for practical use, a variation based on research data of the last twenty years is suggested. Concerning open channels such as canals, flumes, rivers, etc., in agreement with the experience of the last 40 years, the use of the Manning formula is suggested.

## INDIA.

### *Central Government.*

#### FINAL REPORT OF THE DELHI TOWN PLANNING COMMITTEE ON THE TOWN PLANNING OF THE NEW IMPERIAL CAPITAL, 1913.

Considerations leading to the selection of the present site, description of layout, recommendations regarding special points concerning water supply and drainage, etc., are given.

**NEW CAPITAL AT DELHI : APPENDIX TO PRELIMINARY REPORT AND ESTIMATE : NOTES ON HYDRAULIC INFORMATION, 1913.**

Sopwith.

These notes have been prepared from the information collected during the investigations that ended in the selection of the site for the Imperial Capital and deal with the subsoil water and river conditions of the two proposed sites to the north and south of the old city of Delhi.

**MODERN BARRACKS WITH PARTICULAR REFERENCE TO RAWALPINDI (WEST RIDGE).**

Describes a modern type of barracks suitable for air conditioning. The necessity of air conditioning and the essentials of the design of an air conditioning plant are discussed. A statement showing the cost of the barracks is given, together with drawings of the barracks and a children's school attached to them.

**ANNUAL REPORT OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH FOR 1936-37.**

A report of the activities of the Imperial Council of Agricultural Research in various provinces of India. The progress of several Agricultural Research Schemes undertaken by the Council is described and a further programme is given. The agricultural research includes research in sugarcane, rice, wheat and breeding of rust resistant wheats, potato, and horticultural research. Some experiments are being carried out in Bengal to find the minimum water requirements of rice and the critical stages of the growth of rice. A soil research scheme is also in progress in Bengal.

**COPY OF A PRESS NOTE ON "THE SARDA CANAL, (BENGAL)", 25-8-1937.**

This note describes the benefits conferred by the Damodar Canal, and gives a brief history of the canal which was built during the years 1926—1932.

**COPY OF A PRESS NOTE ON 'THE SARDA CANAL, UNITED PROVINCES', 21-9-1937.**

This note gives figures of area irrigated by the Sarada Canal in 1935-36 and the gross receipts and the net revenue during the same period. A brief history of the scheme is given from the early inception of the project in the middle of the nineteenth century to its final sanction in 1920. The difficulties encountered during the construction of the project are related. The main features of the main canal and its branches and of some important works on them are described and certain figures are quoted to indicate the magnitude of the undertaking. The benefits conferred by this project are related.

*Forest Research Institute, Dehra Dun, Timber Development Section.*

The pamphlets mentioned below have been issued by the Forest Research Institute of Dehra Dun to popularize the use of timber in building and other engineering construction. Recently in some advanced western countries, engineers are forming the opinion that wood is the most economical and practical material for many modern structural purposes. This is because of two reasons, firstly, because wood can now be made durable for a very long period and secondly, that new forms of timber joints and wood structures have been evolved. The pamphlets are as below :—

**WOOD'S CHALLENGE TO STEEL AND CONCRETE.**

Pamphlet No. 1.

Kamesam.

The advantages of wood as compared to steel and concrete as structural materials are described.

**RELATIVE ECONOMY OF WOOD, STEEL, AND CONCRETE STRUCTURES.** Pamphlet No. 2.

Kamesam.

Compares costs of timber, steel and reinforced concrete structures.

**MANUFACTURE OF SMALL DIMENSION STOCK A NEW RURAL INDUSTRY.** Pamphlet No. 3.

Kamesam.

“Small dimension stock” refers to wood pieces of different standard sizes. This stock has a ready market in towns and cities. The writer suggests the manufacture of small dimension stock by unskilled labour in rural areas as a measure of improving the earning capacity of the villager.

**THE TRUTH ABOUT FIRE HAZARD IN TIMBER STRUCTURES.** Pamphlet No. 4.

Kamesam.

It is stated that fire hazard in a timber structure is not more than that in a steel or concrete structure.

**CHEAPER AND BETTER GABLE ROOFING WITH WOOD SHINGLES.** Pamphlet No. 5.

Kamesam.

Types of roofing now in use in India are described and a cheaper and better type of timber roofing is suggested.

**TREATED TIMBER FOR EARTHQUAKE RESISTANT STRUCTURES.** Pamphlet No. 6.

Kamesam.

Discusses the action on buildings during an earthquake, analyses relative damage to reinforced concrete, steel framed and wood framed houses, and enumerates some of the advantages of treated wood as an eminently suitable structural material for earthquake resistant construction.

**TREATED WOOD POLES FOR ELECTRIC DISTRIBUTION  
AND SERVICE. Pamphlet No. 7.**

Kamesam.

**BETTER AND CHEAPER FENCING. Pamphlet No. 10.**

Kamesam.

**HOW TO BUILD WOODEN EARTHQUAKE AND STORM-  
PROOF HOUSES. Pamphlet No. 11.**

Kamesam.

Lays down sixteen principles of construction by following which even a layman can build a house for himself of wood-frame construction.

**RELATIVE COST OF TREATED ELECTRIC POLES AND  
OVERHEAD CONSTRUCTION IN INDIA AND ABROAD.  
Pamphlet No. 13.**

Kamesam.

Shows the cheapness of treated timber electric poles as compared to steel poles.

**TREATED TIMBER BRIDGES FOR INDIAN HIGHWAYS  
AND RAILWAYS. Pamphlet No. 15.**

Kamesam.

Discusses timber truss and trestle type bridges and their durability and suitability to Indian conditions both in railway and highway engineering.

**WOOD VERSUS STEEL FOR FRAMED BUILDINGS.  
Pamphlet No. 18.**

Kamesam.

Compares initial cost, effect of weather, safety against fire, maintenance, acoustics and other features of steel frame and wood frame buildings.

**HOW TO BUILD FIRE-RESISTANT TIMBER STRUC-  
TURES. Pamphlet No. 19.**

Kamesam.

Some principles of fire resistant timber construction are detailed.

*Survey of India Department.*

**PAMPHLET CONTAINING SPECIMENS AND PRICES OF  
VARIOUS MAPS AND INFORMATION ABOUT OTHER  
WORK UNDERTAKEN BY THE SURVEY OF INDIA  
DEPARTMENT.**

*Institution of Engineers (India).*

**IMPACT FOR R. C. BRIDGES. (Advance copy of paper)**

Korni.

The problem of impact has been investigated by various authorities in different countries over a large number of years but there is still no clear or definite formula of impact for bridges of different types. Recently the Bridge Standard Committee in India issued a formula for impact for all classes of road bridges. The author analyses free and forced vibration in bridges and gives formulas for their calculation and discusses the effect of spring on impact.

He derives an expression for impact on a railway girder bridge where the rolling load is directly moving on the girders. Impact on reinforced concrete bridges is then discussed and it is shown that deformation due to a moving load is much less in the case of reinforced concrete bridges than in the case of a steel bridge. The impact factor for R. C. bridges can therefore be safely assumed at a considerably less value than that for steel bridges. In conclusion, he suggests values of impacts to be adopted for different types of R. C. Bridges.

## BENGAL.

### *Irrigation Department.*

GOVERNMENT OF BENGAL ANNUAL IRRIGATION REVENUE REPORT FOR THE YEAR 1934-35.

THE BENGAL DEVELOPMENT ACT, 1935.

This is an Act to provide for the development of lands in Bengal and to impose a levy in respect of increased profits resulting from improvement works constructed by the Government.

THE BENGAL TANKS IMPROVEMENT BILL, 1937;  
WITH STATEMENT OF OBJECTS AND REASONS AND  
NOTES ON CLAUSES.

This bill has been enacted to provide for the improvement of tanks in Bengal for purposes of irrigation.

### *Agricultural Department.*

SEASON AND CROP REPORT OF BENGAL AGRICULTURE  
DEPARTMENT FOR THE YEAR 1936-37.

## UNITED PROVINCES.

### *Irrigation Department.*

FINANCIAL HANDBOOK : PUBLIC WORKS ACCOUNT  
RULES, VOL. VI, FIRST EDITION, 1937.

BOOK OF FORMS REFERRED TO IN FINANCIAL  
HANDBOOK, VOLUME VI, 1937.

### *Agricultural Department.*

REPORT ON THE ADMINISTRATION OF THE DEPARTMENT OF AGRICULTURE FOR THE YEAR ENDING  
30TH JUNE, 1936.

## CENTRAL PROVINCES.

*Irrigation Department.*

ADMINISTRATION REPORT OF THE IRRIGATION  
BRANCH FOR THE YEAR ENDING THE 31ST MARCH  
1936.

*Agricultural Department.*

ANNUAL REPORTS OF EXPERIMENTAL FARMS IN THE  
CENTRAL PROVINCES FOR THE YEAR ENDING THE  
31ST MARCH 1936.

REPORT ON DEMONSTRATION WORK CARRIED OUT  
IN THE WESTERN CIRCLE TOGETHER WITH RE-  
PORTS ON THE SEED AND DEMONSTRATION AND  
CATTLE-BREEDING FARMS OF THE CIRCLE FOR  
THE YEAR ENDING THE 31ST MARCH 1936.

## PUNJAB.

*Irrigation Department.*

ADMINISTRATION REPORT WITH STATISTICAL STATE-  
MENTS AND ACCOUNTS FOR 1934-35.

COMPLETION REPORT AND SCHEDULES, SIRHIND  
CANAL, 1893.

IRRIGATION BRANCH TECHNICAL NOTES, CLASS B,  
No. 2—NOTE, DATED 10TH SEPTEMBER 1922  
ON "MASONRY SETTINGS FOR KENNEDY'S  
GAUGE OUTLETS".

A type design for a masonry setting for gauge outlets is given  
and practical considerations leading to the design of this  
particular type of setting are discussed.

REPORT ON INFORMATION REGARDING IRRIGATION  
AND DRAINAGE, WITH SPECIAL REFERENCE TO  
WATER-LOGGING, COLLECTED DURING A JOUR-  
NEY FROM BOMBAY TO ENGLAND, VIA AUSTRA-  
LIA, NEW ZEALAND, PANAMA, HAVANA AND THE  
UNITED STATES OF AMERICA, BETWEEN 1ST  
MAY, 1935 AND 23RD AUGUST, 1935.

Montagu.

The author (formerly Secretary of the Central Board of Irriga-  
tion) gives a brief account of the origin of the tour under-  
taken by him and gives a detailed description of the tour  
arranged in chronological order. He has described in  
detail the various works visited and the various problems  
discussed by him in the course of his tour with engineers  
and other persons in the countries visited.



The report is extremely interesting and contains information on a large variety of subjects, some of which are mentioned below :

Waterlogging problems in Victoria State and their solution.

Destruction of surplus energy on the standing wave principle at the Madden Dam in Panama and mud grouting of limestone fissures to prevent leakage.

The Mississippi River channel, and the Bonnet Carre spillway; articulated concrete slabs to check erosion at river bends; the U. S. waterways experiment station at Vicksburg and experiments with concrete models of the Mississippi River; block revetments for river bank protection; inspection of river channel.

The Bureau of Reclamation research laboratories at Denver, Colorado, and investigations being carried out there; laboratory for the testing of earth materials; hydraulic laboratory for model tests of spillways of various dams.

Inspection of the Rio Grande Project; discussion of the problem of waterlogging with Mr. Fiock, the leading authority on waterlogging in the service of the Bureau of Reclamation.

The cement and concrete testing laboratories at Denver, Colorado.

A discussion on the question of carrying out works by direct labour under the control of the officers of the Bureau instead of through contractors.

### *Irrigation Research Institute, Punjab.*

#### RELATIVE EFFICIENCY OF A VERTICAL SHEET PILE Malhotra.

UNDER A FLUSH FLOOR. Research Publication, McKenzie-Taylor. Vol. II, No. 19, October 1936.

"A new symmetrical expression is obtained for the pressure taken up by a pile placed anywhere under a flush floor. It is shown that pressure cut off by the pile is greatest when it is placed at the ends of the floor, and least when it is in the middle.

The lengths of piles placed at different points under the floor and cutting off the same fraction of total head are investigated.

The variation of the head cut-off by the pile with changes in its depth is studied".

**SOME NOTES ON KHOSLA'S PRINCIPLE OF INDEPENDENT VARIABLES. I—MUTUAL INTERFERENCE OF EQUAL PILES AT ENDS OF A FLOOR.** Malhotra. McKenzie-Taylor. Research Publication, Vol. II, No. 20, October 1936.

While investigating the design of weirs on permeable foundations, Rai Bahadur A. N. Khosla obtained an empirical formula for the correction to percentage pressure due to the mutual interference of piles. The authors were recently able to obtain a theoretical solution for the standard case of a floor provided with equal end piles. The same investigation was also carried out experimentally by electric methods. The percentage pressures as obtained by the theoretical method, as obtained by Mr. Khosla's empirical formula, and as determined by experiments are compared, and it is found that there is a remarkable agreement between theory and Mr. Khosla's values. It is shown that there is a theoretical basis for the formula within the range of floor-piles ratio met with in actual practice. The formula is further extended to include all values of the above ratio.

*Buildings and Roads Branch.*

PUNJAB P. W. D. SPECIFICATIONS, VOL. I, 1936

(Buildings and Roads).

A handbook of specifications for all materials commonly used and methods of construction in the Public Works Department, Punjab.

*Legislative Department.*

PUNJAB LEGISLATIVE ASSEMBLY DEBATES, VOL. I,  
Nos. 9 & 10, June 1937.

Certain questions were asked in the Punjab Legislative Assembly regarding :

1. Fall of water level in Jullunder and Hoshiarpur Districts.
2. The Bhakra Dam Scheme.
3. Water rates.

These questions and their answers are given, and also the general discussion on the budget.

## BOMBAY.

*Irrigation Department.*

IRRIGATION ADMINISTRATION REPORT, BOMBAY PRESIDENCY, PART II—ADMINISTRATIVE ACCOUNTS AND STATISTICAL STATEMENTS FOR THE YEAR 1934-35.

COPY OF NOTE, DATED 7TH AUGUST 1913 OF THE CHIEF ENGINEER FOR IRRIGATION, BOMBAY, (MR. H. F. BEALE), REGARDING LOWER SITES FOR THE BARRAGE AT SUKKUR.

The question of selecting site below the gorge at Sukkur for the barrage was considered in 1905 and the reasons why

such a site was considered unsuitable are given. Considerations for location of the site above the gorge are then discussed in detail. Attention is drawn to the possibility of the formation of shoals between the guide banks above the barrage and the general raising of the river bed for some miles upstream. In conclusion, the objections to the lower sites are summarized.

#### HISTORY OF CANAL HEADWORKS—EKruk TANK, SHOLAPUR.

The Ekruk Tank comprises a reservoir formed by an earthen dam 7,000 feet long and 76 ft. maximum height. The area of waterspread is  $6\frac{1}{2}$  sq. miles. A history of the project is given and a number of plans containing details of the project are attached.

#### A CONCISE HISTORY OF THE GOKAK CANAL AND STORAGE WORKS IN THE BELGAUM DIVISION, UP TO THE YEAR 1936-37.

This project consist of a weir across the river Ghataprabha 6,836 ft. long with a maximum height of 27 ft. and comprising a masonry section 2,985 ft. long flanked by earthen bunds. A canal system takes off from behind this weir for the irrigation of the surrounding country. The works are described and a brief history of the inception of the project is given.

#### HISTORY OF THE MHASWAD TANK AND CANALS UP TO THE YEAR 1936-37.

The scheme is described and its history is traced back to its first inception in 1887. The scheme consists of a reservoir formed by an earthen dam 9,000 ft. long with a maximum height of 80 ft. across the river Rajewadi and a canal taking off from the reservoir. Details of the tank, the dam with its core of selected soil going down to impermeable rock, the waste weir, and the canals are given.

#### HISTORY OF THE MUTHA CANALS SYSTEM (KHADAKWASLA DAM) UP TO THE YEAR 1936-37.

This system comprises a masonry dam across the Mutha River at Khadakvasla about 11 miles from Poona, and a system of canals taking off from the river. The dam consists of a concrete core section covered with masonry on both faces. It is 4,827 ft. long and is 102.5 ft. high above the river bed. It goes down another 28 ft. below the river bed to rock and the base width at foundation level is 75 ft. The waste weir consists of 88 automatic gates, 12 rolling gates and 3 needle gates. Details of the canals are given.

### **HISTORY OF THE HEADWORKS OF GIRNA CANAL (CHANKAPUR DAM) UP TO THE YEAR 1936-37.**

This briefly describes the works which consist of Chankapur storage tank and a pick up weir lower down with a system of canals. The storage tank is formed by the Chankapur Dam, a rubble and lime masonry structure on solid rock foundations 1,506 ft. long with a maximum height of 140 ft. The pick-up weir which is 23 miles below the storage tank is of stone and lime masonry and is 1,100 ft. long. Details of length of canals and areas commanded are given.

### **HISTORY OF THE HEADWORKS OF GODAVARI CANALS (DARNA DAM) UP TO THE YEAR 1936-37.**

The principal details of the scheme are given. The works consist of a storage reservoir and a pick-up weir. The dam forming the storage reservoir is a gravity structure of uncoursed rubble masonry in lime, the top portion of the dam consisting of concrete hearting with masonry faces. It is 5,360 ft. long with a maximum height of 94 ft. Details of the pick-up weir and head regulator are given.

### **HISTORY OF THE PRAVARA CANALS HEADWORKS (WILSON DAM AND PICK-UP WEIR AT OJHAR).**

This scheme comprises the Wilson Dam at Bhandardara and the Pravara canals. The Wilson dam is by far the highest dam in India being 270 ft. above river bed level. Water stored in the reservoir formed by this dam is released into the river and is later passed into the Pravara Canals by a pick-up weir 53 miles below. Details of length of the canal systems and areas commanded are given.

### **HISTORY OF THE NIRA CANALS HEADWORKS (LLOYD DAM AND PICK-UP WEIR AT VIR).**

The storage reservoir for the Nira Canals is formed by the Lloyd Dam at Bhatgarh which is a masonry structure 5,330 ft. long, and 194 ft. high above foundation level. The lake formed by the dam has a catchment area of 128 sq. miles. Foundations of the dam are described. The pick-up weir for the canals is 17 miles below the reservoir. Brief history of the construction of the Nira canals is given and main features of the canals are described.

### **HISTORY OF THE HATHMATI AND KHARI CUT CANALS HEADWORKS.**

These works are in the Bombay Presidency. Their history is traced and they are briefly described.

## HISTORY OF THE VISAPUR TANK AND CANAL PROJECT UP TO THE YEAR 1936-37.

The Visapur Tank is formed by an earthen Dam, 7,440 ft. long and with a maximum height of 84 ft. The reservoir is designed to store 1,329 million cubic ft. The headworks consist of a masonry culvert 225 ft. long passing through the dam and controlled from a tower built on the inner side of the dam. The canal system is briefly described.

### SIND.

*Public Works Department (Irrigation).*

### IRRIGATION ADMINISTRATION REPORT FOR THE YEAR 1933-34. PART II.

REPORT ON EXPERIMENTS WITH A MODEL OF KHESANO REGULATOR ON THE ROHRI CANAL, MILE NO. 194. CARRIED OUT IN THE DEVELOPMENT AND RESEARCH DIVISION AT THE KARACHI TESTING STATION. Sind P. W. D. Technical Paper No. 1.

Bushby.  
Hiranandani.

The Chief Engineer, Sind, noticed a very unusual intensity of turbulence below the regulator and a large eddy and back current in the expanding flume. It was also noticed that at times the current changed sides due to some unaccountable disturbance in the conditions of the flow, the current generally being deflected to the left. It was therefore considered necessary to construct a model of the regulator to find the necessary modifications which would produce an even flow.

The model was constructed 1/12 full size and details of its construction are described. A number of experiments were conducted with baffles in various positions to determine the final modification to be adopted. The principles of fluming as contained in Central Board of Irrigation Publication No. 6 were also tried but with no success. Brief descriptions of the experiments are given. The final plan adopted was a baffle which enabled the standing wave to be formed upstream of it and dissipated the surplus energy.

In conclusion it is stated that the experiments proved beyond doubt that conditions in the prototype could be reproduced in the model with a fair amount of accuracy.

A number of plates giving details of the various experiments carried out are included.

**REPORT ON OBSERVATIONS ON THE JAMRAO CANAL  
SYSTEM TO STUDY CONDITIONS FOR NON-SILTING  
CHANNELS IN SIND, 1930—33.**

In August 1929 the Chief Engineer in Sind was asked to carry out an investigation to study conditions for non-silting channels in Sind. The items of enquiry are :

- (1) Do the dimensions of regime channels in Sind support Kennedy's formula in its fundamental form?
- (2) If so, are the constants the same for Sind as for the Punjab?
- (3) If not, what values are to be adopted?
- (4) If the dimensions of regime channels in Sind do not support the Kennedy formula do they indicate any other formula connecting critical velocity with depth or connecting the discharge carrying a given silt charge with dimensions of the channel?
- (5) Is the critical velocity in any way connected with the hydraulic mean depth?

The Jamrao canal system running for over 30 years was selected and 22 sites of varying discharges from 10 to 200 cusecs were fixed upon for observations.

This report gives the procedure adopted for taking observations and the result of observations. The results are discussed in great detail. In conclusion, replies to the items of enquiry mentioned above are given on the basis of the results obtained.

**STATEMENT SHOWING FINAL AREAS OF RABI CULTI-  
VATION AS COMPARED WITH FORECASTED FIGURES  
FOR THE YEAR 1936-37 FOR THE LLOYD BAR-  
RAGE CANALS.**

"There is a decrease of cultivation to the extent of 17,545 acres. The decrease is due to slump in the price of wheat and more area coming under cotton crop, it being more paying."

**WEEKLY STATEMENTS SHOWING KHARIF CULTIVA-  
TION AREAS UP TO 11TH SEPTEMBER 1937 IN  
SIND AS COMPARED WITH THOSE OBTAINED UP  
TO THE CORRESPONDING DATE LAST YEAR.**

There is an increase of cultivation to the extent of 9,877 acres on the Right Bank canals and 141,233 acres on the Left Bank canals.

*Agricultural Department.***ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE IN SIND FOR THE YEAR 1935-36.****Jenkins.**

In Chapter II the working of the Barrage Canals and effect on agriculture in the Barrage areas in 1935-36 are discussed. Chapter III deals with agricultural research and investigation which include investigations on cotton, wheat, rice, and soil and irrigation research. The water requirements of main crops grown in Sind have been studied in great detail at the Agricultural Research Station, Sakrand. Maintenance of soil fertility has also been a matter for study.

**MADRAS.***Public Works Department.***MADRAS PUBLIC WORKS DEPARTMENT ADMINISTRATION REPORT FOR THE YEAR 1935-36. PART II—IRRIGATION.**

CIRCULAR MEMORANDUM No. 216-Wks./35—8,  
DATED 22ND MAY 1936, REGARDING BUILDING  
FOUNDATIONS IN BLACK COTTON SOIL.

Some general principles to be followed in the design of buildings to be founded on black cotton soil are laid down and the causes of cracks in buildings founded on that soil are discussed.

**BALUCHISTAN.***Agricultural Department.***ANNUAL REPORT OF THE AGRICULTURAL DEPARTMENT IN BALUCHISTAN FOR 1936-37.**

The report contains detailed information about fruit research carried out in Baluchistan and a general account of the operations of the Department of Agriculture.

**INDIAN STATES.***Mysore State (Public Works Department).***MARCONAHALLI RESERVOIR PROJECT, MYSORE STATE.**

This projected scheme comprises a reservoir formed by a masonry dam across the river Shimsha. The proposed dam consists of a masonry section 456 ft. long with two earthen

flanks at either ends, 2,508 ft. and 2,310 ft. long respectively. Other details of the project such as catchment and yield, capacity of reservoir, run-off and discharges adopted, and works appurtenant to the dam are given. The canal system is also described in brief.

## IRRIGATION IN MYSORE.

This is a note describing irrigation conditions in Mysore State. The irrigated area in the State is about one-sixth of the total cultivated area. The bulk of irrigation is done from tanks numbering about 25,000 and irrigating about 8 lacs acres out of a total irrigated area of  $11\frac{1}{4}$  lacs acres. There are about 40,000 wells irrigating about one lac acres of area. Amongst river channels, the Cauvery river channels irrigate about 1.15 lacs acres and by the recent construction of the Krishnaraj Sagar Dam it has been possible to increase this area by another  $1\frac{1}{4}$  lacs acres. Irrigation from Cauvery has almost reached its limits.

### *Mysore State (Department of Agriculture).*

FACTORS AFFECTING SPRAY SUCCESS IN THE CONTROL OF COFFEE LEAF DISEASE. Mysore Coffee Experiment Station Bulletin No. 15.

Mayne.

ANNUAL REPORT OF THE COFFEE SCIENTIFIC OFFICER, 1936-37. Mysore Coffee Experiment Station Bulletin No. 16.

Mayne.

BRIEF INSTRUCTIONS FOR THE GUIDANCE OF LAY PERSONS REGARDING IMPROVEMENT OF ANIMAL INDUSTRY, CHIEFLY CATTLE, SHEEP AND POULTRY. Circular No. 56.

Monteiro.

THE COFFEE STEM BORER AND ITS CONTROL. Circular No. 57.

SOME DO'S AND DON'TS IN REGARD TO POULTRY AND SHEEP BREEDING. Circular No. 58.

## BURMA.

### *Irrigation Department.*

ADMINISTRATION REPORT OF THE PUBLIC WORKS DEPARTMENT (IRRIGATION BRANCH), BURMA FOR THE YEAR 1935-36.



## MALAYA.

ANNUAL REPORT OF THE DRAINAGE AND IRRIGATION  
DEPARTMENT OF THE FEDERATED MALAY STATES  
AND THE STRAITS SETTLEMENTS FOR THE YEAR  
1936.

Robinson.

This contains information on irrigation, drainage and river conservation operations in the Federated Malay States and the Straits Settlements. An important advance made is the replacement of temporary brushwood dams on rivers by permanent masonry dams with a special type of radial gate developed to meet the river flood conditions encountered. River training operations are described and some of the river training works are unique.

## SUDAN.

*Irrigation Department.*

A REPORT ON A STUDY OF INDIAN IRRIGATION WORKS. Williams.

This report records the results of a tour undertaken by the author, of Irrigation works in India. The author visited Sind, the Punjab, the North-West Frontier Province, the United Provinces, and the Bombay Presidency. The report describes the organization of a typical Indian Irrigation Department and its administration. Canal works of various types including headworks, falls, regulators, etc., visited by the author are described and principles of design of spillway syphons, non-silting offtakes, flumed works, river training works, and ease and cut waters for piers have been outlined. One full chapter is devoted to research in Irrigation in which investigations being carried out on irrigation problems in various provinces are mentioned and several of the conclusions of these investigations have been embodied. Some of the more important headworks and the problems that had to be tackled in their design and construction are described. Mr. Lacey's theory of stable channels in alluvium is discussed at length, and the problem of waterlogging is dealt with.

The book contains very useful information for engineers in India and the author has referred to problems in Egyptian canals to which the knowledge gained by him during his Indian tour could be advantageously applied.

## AFRICA.

ANNUAL REPORT OF THE BRITISH EAST AFRICAN  
METEOROLOGICAL SERVICE FOR THE YEAR 1936.

## UNITED STATES OF AMERICA.

*Department of Agriculture.*

## SNOW-SURFACE TEMPERATURE.

Horton.

Reprint from Monthly Weather Review, Vol.  
62, April 1934.

Leach.

In studying evaporation losses for high altitudes it becomes important to determine the mean snow surface temperature. Observations of snow-surface temperatures were made by the authors using maximum and minimum thermometers. The results are presented herein.

## BIBLIOGRAPHY ON LAND DRAINAGE.

A complete bibliography on the subject of drainage. The names of the publications are arranged under different subjects and countries, and an author index is given at the end.

*Department of the Interior (Bureau of Reclamation).*

SECOND ANNUAL REPORT (SIXTH PROGRESS REPORT—  
16TH, 17TH, 18TH AND 19TH SETS) ON RETRO-  
GRESSION OBSERVATIONS BELOW BOULDER DAM  
WITH NOTES ON OTHER SILT INVESTIGATIONS ON  
THE COLORADO RIVER AND THE ALAMO CANAL,  
MAY 27, 1937. (Confidential).

Corfitzen.

The results of the 16th, 17th, 18th and 19th sets of observations on the retrogression of the Colorado River bed below Boulder Dam are presented in this publication, and a resume of results of all previous observations is given. Observations on the suspended load of the Colorado River at Imperial Dam site and at Red Cloud Cable Station 23 miles upstream and in the Alamo Canal are also presented.

*Department of Public Works.*

CENTRAL VALLEY PROJECT UNIT BIDS OPENED.  
KENNETT DAM SITE APPROVED BY U. S. Reprint  
from Official Journal of the Department of  
Public Works, March 1937.

Kelly.

This pamphlet describes the progress of the project. The Kennett Dam is the key structure of the project; and the site for the dam has been approved. The U. S. Bureau of Reclamation is the constructing agency and they have started preparatory work. The Kennett dam will be constructed of concrete and will be about 420 ft. high. The reservoir so formed will serve several purposes. A portion of its capacity will be reserved during winter and early spring for control of floods. A cyclax core drilling machine used for exploration of site of the dam is illustrated. This drill removes a core of rock 3 ft. in diameter.

*War Department (U. S. Waterways Experiment Station, Vicksburg).*

**THE IMPROVEMENT OF THE LOWER MISSISSIPPI  
RIVER FOR FLOOD CONTROL AND NAVIGATION.  
In 3 volumes.**

Elliott.

This publication presents a comprehensive outline of the history of the improvement of the Lower Mississippi River for flood control and navigation from the time of the discovery of the Mississippi River to the present day.

It begins with the history of discovery of the river and the establishment of settlements along it. The growth of settlements was followed by improvement in navigation. Levee building dates back to the time of the earliest settlements which were established in the beginning of the eighteenth century. The problem of flood control came into prominence after the floods of 1849-1850. The history of the formation of the first Mississippi River Commission is traced leading up to the reorganization of the Commission in 1928.

The physical characteristics of the Lower Mississippi River are then described. The river has an alluvial valley and the drainage basin has an area of 1,245,000 sq. miles which is 3 times as large as the area of the Ganges Basin. The river banks consist of alluvial deposits and are subject to more or less continuous erosion in the shape of caving and sinking. The occurrence of cut-offs and their effects on stages above and below are discussed in some detail. A short description of important recorded natural cut-offs on the Mississippi is given.

In discussing the hydraulics of the lower Mississippi it is observed that confinement of flood waters within levees has increased elevations of flood crests considerably. The method of calculation of discharge of the Mississippi River is given. The sediment investigations made on the lower Mississippi and the characteristics of the river in relation to the transportation of solid matter are discussed.

One whole chapter deals with the levee system of the Lower Mississippi. The development of the levee system from the earliest times to the present day is outlined. The useful life of a levee is considered to be 30 years. Levee construction methods and implements are described in detail.

Other items dealt with are improvement of navigation by dredging, bank protection methods, and contraction works for decreasing the low water channel width and increasing the depth with a view to improve navigation.

The last chapter contains a theoretical discussion of flood control methods with particular reference to the Mississippi River. The principles governing the preparation of a flood control plan are discussed at length. Flood control methods discussed are reforestation, channel relocation, which involves the diversion of the flow of tributary streams to the sea by artificial channels, river channel enlargement, river channel shortening, reservoirs for flood storage, floodways or outlets, and levees. The development of the Lower Mississippi flood control works is traced from the earliest times and the various flood control plans prepared before the institution of the Mississippi River Commission in 1879 are discussed in detail. These plans were not executed at the time for various reasons. The flood control plans of the Commission are also described and the progress of flood control operations is traced up to the reorganization of the Commission in 1928. A reservoir Board was appointed to report on the suitability of reservoirs for flood control in 1927 before the phenomenal floods of that year. The Committee was of opinion that although reservoirs would reduce floods, the protection so afforded would not eliminate use of other flood control works. After the 1927 floods, a number of flood control plans were prepared, the chief amongst which were the plan of the Mississippi River Commission, and the Jadwin plan. These plans are discussed in detail. The Jadwin plan was ultimately adopted for execution. A brief description of floodways as proposed in the plan is given.

*National Research Council (American Geophysical Union).*

TRANSACTIONS OF THE SEVENTEENTH ANNUAL MEETING APRIL 30, MAY 1, 2, 1936 AND WEST COAST MEETING JANUARY 31 AND FEBRUARY 1, 1936.  
PART II—REPORTS AND PAPERS SECTION OF  
HYDROLOGY AND WESTERN INTERSTATE SNOW-SURVEY CONFERENCE.

Reports and papers under the hydrology section are contained in this publication. The following are some of the reports and papers under this section :—

Report of Committee on Absorption and Transpiration.

Report of Committee on Rainfall and run-off.

Report of Committee on Physics of soil moisture.

Report of Committee on Underground waters.

Report of Committee on Dynamics of streams.

Some problems relating to fluctuations of groundwater level.

Long time records of groundwater levels on Long Island.

Maximum groundwater levels.

Fluctuations in groundwater at Woodgate, New York.

Decline of Artesian head in South Dakota.

Recovery of groundwater levels in Nebraska.

Fluctuation of groundwater level in Utah.

The underground water index : its relation to surface run-off.

Seepage of water through porous media under the action of gravity.

Historical development of ideas regarding the origin of springs and groundwater.

Methods of studying fluctuations of groundwater levels.

Notes on the transportation of silt by streams.

The twin problem of erosion and flood control.

Experimental study of the scour of a sandy river bed by clear and muddy water.

Fluvial morphology in terms of slope, abrasion, and bed load

*American Farm Bureau Federation.*

SIXTH ANNUAL CONFERENCE OF INSTITUTE OF  
IRRIGATION AGRICULTURE, MARCH 30, 31 AND  
APRIL 1, 1937.

Some of the papers presented are as follows :—

Forecasting irrigation water supply by snow survey.

Irrigation practice as a factor in soil erosion.

A discussion and demonstration of the fundamentals of soil  
and water relations as applied to irrigation practice.

The Willamette Valley project from the viewpoint of the  
farmer.

Artificial recharging of underground water supplies.

Correlation of Range Land Use with Irrigation project needs.

Factors that determine the feasibility of a reclamation  
project.

*American Association for the Advancement of Science.*

THE SCIENTIFIC ASPECTS OF FLOOD CONTROL :

A SYMPOSIUM. Supplement to "Science",

Vol. 84, No. 3, October 1936.

Silcox.

Lowdermilk.

Cooke.

The symposium consists of the following :—

INTRODUCTION BY COOPER.

Explains the relation of the science of ecology with flood control.

Ecology is the science of plants and animals.

## FORESTS AND FLOOD CONTROL.

Silcox.

Discusses the part played by forests in flood control. Adequate forest cover on the watersheds alleviates flood crests and reduces the frequency of floods. Forest conditions in the early days of settlement in America are compared with the present day conditions and it is stated that destruction of forest cover has resulted in quicker run-off, floods, erosion of top soil, and depletion of groundwater storage due to quicker run-off. Erosion conditions in the U. S. A. are described and the means of controlling floods and erosion are discussed. The soil conservation service in the U. S. A. is carrying on a programme of erosion and stream flow research and erosion control. Some examples of the effect of forest cover upon stream flow and flood crest are quoted and their beneficial effects are emphasized. The manner in which forest cover helps in soil conservation and reduction of run-off, and the chemistry of the process are described. The question of silting of reservoirs by silt formed by erosion is mentioned and a strong case is made out for "upstream engineering" in flood and erosion control.

## AGRICULTURAL LAND USE AND FLOOD CONTROL.

Lowdermilk.

Effect of a proper agricultural land use programme on average annual run-off and soil loss is discussed and it is shown that woodlands and grasslands on steep slopes absorb all but a few per cent. of the total annual rainfall. Hazards of cultivation of land are considered and principles of safe and sustained land use so as to obviate these hazards are discussed. Land use for the prevention and control of erosion is described and strip cropping, terracing, and similar measures are discussed. Erosion control measures are designed to meet one or more of the following objectives: (1) to increase the capacity of cultivated soils to absorb and infiltrate water so that there is no depletion of underground storage (2) to provide for retardation and control of surface flowage (3) to rehabilitate soils which are damaged or ruined by erosion. Each of the above objectives and the means of attaining it are discussed.

## ON THE RELATIONS OF ENGINEERING SCIENCE TO FLOOD CONTROL.

Cooke.

The author believes that flood control is a problem of up-stream as well as down-stream engineering. Prevention as well as counteraction are both necessary. The value of up-stream engineering in erosion control and flood control is emphasized.

*University of Arizona, Agricultural Experiment Station.*

GROUNDWATER LAW IN ARIZONA AND NEIGHBOURING STATES. Technical Bulletin No. 65, December 29, 1936.

Smith.

This Bulletin discusses the principles of groundwater law and the existing law in Arizona and neighbouring States.

*Ohio State University Engineering Experiment Station.*

LIST OF PUBLICATIONS ISSUED BY THE STATION.

SOIL SURVEYS FOR HIGHWAYS. Circular No. 33, July 1936.

Eno.

A brief history of soil survey methods with a review of present practices is contained in this publication.

*Tennessee Valley Authority.*

TENNESSEE VALLEY AUTHORITY, 1933—1937.

The Tennessee Valley Authority was constituted by the U. S. Government in 1933 with the object of controlling and utilizing the Tennessee River for the benefit of the surrounding country. The Authority is carrying out an integrated plan of development of the Tennessee River for navigation, flood control, agricultural development and national defence. This pamphlet outlines the problems which the Authority has faced, the manner in which it has dealt with them, the results so far attained, and the work which still remains to be done.

The navigation and flood control plan comprises the construction of a series of high dams on the Tennessee River. To make tests of conditions at dam sites, a soil mechanics laboratory was established at Norris in 1935 where soils for embankments and foundations are tested. All dams are tested by model experiments at the authority's Hydraulic Laboratory at Norris.

Power production and the future market for power are discussed. Soil conservation is an important item of the unified plan and comprises a forestry programme. (See also page 79 *et seq* of Bulletin No. 5.)

*Carnegie Institution of Washington.*

DELTA, ESTUARY, AND LOWER PORTION OF THE CHANNEL OF THE COLORADO RIVER, 1933 TO 1935.

Sykes.

This report presents the results of field and laboratory studies together with a digest of other data obtained from various sources which are relevant to recent developments and present conditions in the Delta region of the Colorado

River. The investigation embraces that portion of the river system extending from Boulder Dam to the Gulf of California, and the period covered is from the midsummer of 1933 to the end of 1935, during which time the supply of detritus from the main Colorado drainage system has been gradually cut-off. The investigations include discharge observations at the head of the delta, measurement of quantities of silt transported by the Colorado River to its delta, seasonal fluctuations of silt content of Colorado River, bed silt sampling and analyses, the effect of river control on the movement of bed silt already deposited, bed silt movement and redeposition, mechanical analysis of bed silts, and investigation of characteristic changes in the delta area brought about by the absence of the fertilizing waters of the river flowing over it. The author describes his method of examination and appraisal of the channel bed material, and the improved method of silt sampling used. He gives his interpretation of the observed changes in texture of the bed silts. This study of the first years of the controlled life of the Colorado is of great scientific interest and the conclusions are based on exact quantitative data.

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## AUSTRALIA.

### *Council of Scientific and Industrial Research.*

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| A SOIL SURVEY OF THE COOMEALLA, WENTWORTH<br>(CURLWAA), AND POMONA IRRIGATION SETTLE-<br>MENTS, N. S. W. Bulletin No. 107. | Marshall.<br><br>Walkley. |
|--|---------------------------|

Gives the results of a soil survey of three irrigation settlements in New South Wales.

- THE BASALTIC SOILS OF NORTHERN TASMANIA.  
Bulletin No. 108.

Stephens.

In this report are set out the results of an examination of the basaltic soils of Northern Tasmania.

- FURTHER OBSERVATIONS ON SOIL EROSION AND SAND  
DRIFT, WITH SPECIAL REFERENCE TO SOUTH-  
WESTERN QUEENSLAND. Pamphlet No. 70.

Ratcliffe.

Report of a visit to South Western Queensland made for the purpose of collecting data on wind erosion and sand drift.



## INTERNATIONAL CONFERENCES, ETC.

*International Commission on Large Dams, World Power Conference.*

MINUTES OF THE EXECUTIVE SESSION OF THE INTERNATIONAL COMMISSION ON LARGE DAMS OF THE WORLD POWER CONFERENCE HELD IN PARIS, JUNE 28, 1937.

Contains the minutes of the Executive Session describing the business transacted which includes review of the finances, addition to memberships and other matters of executive concern.

SECOND WORLD POWER CONFERENCE, BERLIN  
16—25 JUNE 1930. GENERAL REPORTS.

This publication contains short summaries of papers presented to the Second World Power Conference arranged under different subjects. There is a general report outlining the main points in the papers under each subject and the points for discussion arising out of the papers are also given. The papers generally deal with problems of generation, transmission and use of electricity. There are three papers under the subject of dams. The main points dealt with in the 3 papers are :

The stability of dams.

The discharge of flood water.

Regulations governing the construction of dams.

In the general report on the subject of dams, gravity dams, arch dams, buttressed dams and earth dams are compared as regards their strength and other characteristics.

*International Association for Bridge and Structural Engineering.*

SECOND CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING, BERLIN-MUNICH, 1ST—11TH OCTOBER 1936. PRELIMINARY PUBLICATION.

This publication contains advance copies of papers presented to the Second Congress of the International Association of Bridge and Structural Engineering for the use of delegates and others. The papers are arranged under 8 different heads. Some of the papers under the various heads are mentioned below :

- I. Importance of the Toughness of steel for calculating and Dimensioning steel structural work, specially when statistically indeterminate.

There are 8 papers under this head mostly dealing with the theory of plasticity and theory of indeterminate structures.

## II. Stresses and Degree of Safety in Reinforced Concrete structures from the Designer's point of view.

The following are some of the papers given under this head :—

1. Strength of concrete and reinforced concrete under sustained and frequently repeated loading—O. Graf.
2. Tensile strength and formation of cracks in concrete—E. Bornemann.
3. Tensile strength of stressed parts in reinforced concrete—G. Colonnetti.
4. Practical improvements in the mechanical treatment of concrete—E. Freyssinet.
5. Cracking in reinforced concrete—F. G. Thomas.
6. Use of high grade steel in reinforced concrete—R. Saliger.
7. Concreting and dilatation joints in engineering structures—F. Baravalle.

## III. Practical Questions in connection with welded steel structures.

There are 25 papers under this head dealing with design and execution of welds with special consideration of thermal stresses, inspection and control of welded joints, and strength and safety of welded structures under load. A number of papers describe experience obtained with welded structures in various countries.

## IV. Recent Points of View concerning the Calculation and Design of Bridge and Structural Engineering in Reinforced Concrete.

The following papers are amongst those given under this head :—

1. Solid Domes, cylindrical reservoirs and similar structures.
2. Present day tendencies in large reinforced concrete constructions.
3. Wide span reinforced concrete arch bridges.

## V. Theory and Research work on details for steel structures of welded and Riveted Construction.

There are twelve papers under this head.

## VI. Concrete and Reinforced Concrete in Hydraulic Engineering (Dams, pipe lines, etc.).

The following papers are included under this head :—

1. Development of the Analysis of Arch Dams.
2. The use of concrete in the construction of solid dams.
3. Reinforced concrete piles during driving.

4. Use of concrete in dam construction in Germany.
5. Reinforcement of pressure pipes for the Mareges Dam.

VII. Application of steel in Bridge and Structural Engineering and in Hydraulic Construction.

The following are some of the papers under this head.

1. Use of steel in Bridge building.
2. Use of steel in hydraulic structures.
3. Welded weirs and sluice gates in Belgium.
4. The steel structures of the hydro-electric plant at Wettingen.

VIII. Research Concerning Building Ground.

The following papers are given.

1. Soil studies for the Storstrom Bridge, Denmark.
2. Subsidence in Bridge Construction on the German State Arterial Roads.
3. Report on Dynamic Soil Tests.
4. Limits of Equilibrium of earths and Loose Materials.

The publication consists of nearly 1,600 pages and a short summary of each paper is given at the end of the paper.

*International Union of Forest Research Institutes.*

NOTE ON THE OBSERVATION OF THE PHREATIC (SUB-SOIL) WATERS IN HUNGARY (in French). (Paper presented at the IXth Congress, 1936.)

This describes the methods adopted to correlate the exchange of water between the soil and the atmosphere, with particular reference to evaporation, surface run-off, infiltration, and sub-soil flow.

*Permanent International Association of Navigation Congresses.*

ILLUSTRATED TECHNICAL DICTIONARY. CHAPTER  
XII—MARITIME SIGNALS.

This illustrated technical dictionary is published in six languages—French, English, German, Spanish, Italian and Dutch. This is Chapter XII dealing with Maritime signals.

*International Society of soil science.*

LITERATURE RELATING TO "PROPOSALS FOR RESOLUTIONS" AT THE MEETING OF THE SIXTH COMMISSION OF THE INTERNATIONAL SOCIETY OF SOIL SCIENCE (COMMISSION FOR THE APPLICATION OF SOIL SCIENCE TO LAND AMELIORATION) AT ZURICH IN AUGUST 1937.

The proposals for resolutions are in the form of recommendations which were formulated at the meeting of the Sixth Commission of the International Society of Soil Science and relate to the following subjects.

1. Soil and Water. It is recommended that particular attention should be paid to the influence of soil cultivation on soil moisture relations.
2. Drainage Research. To ensure the international usefulness of drainage investigations, the lines on which investigations are to be conducted are laid down.
3. Sprinkling Irrigation and Sewage utilization.
4. Subterranean Irrigation.
5. Classification of peat soils.
6. Liming and Manuring of peat soils.

## OTHER PUBLICATIONS.

THE STUDY OF THE SOIL IN THE FIELD.

Clarke.

Soil science is a complex study involving many branches of science such as physics, chemistry, geology, botany, etc. One aspect of soil study which is of fundamental importance is the study of the soil in its environment. In the past, this aspect of soil study has been neglected at the expense of laboratory investigations. The author of this book has made it his special study and has endeavoured to put together his own experience and that of other workers so that it may be helpful to students and other workers in the field of soil investigations.

Soil site characteristics and soil profile characteristics are the first things to be determined in a study of the soil in the field. A method for the description of soil site and soil profile characteristics developed by the Oxford Soil Science Laboratory and used with success in many investigations is given. Items which are to be studied in obtaining a complete knowledge of soil site characteristics include age of site, parent material, mode of formation, topography, drainage, climate, vegetation, and effect of man's interference and management. Features to be

studied for a description of the soil profile are :—Colour, nature of material, organic matter, texture, structure (size and shape of aggregates), mineral skeleton, and special characteristics such as degree of moisture content and pH values.

Each of the above items and features on which information is to be collected is treated in detail and directions for the help of the practical investigator are given. The influence of some of these features in the formation of the soil is discussed. In some cases, there are different systems of classification adopted in England, America and Russia for some of the items under soil profile characteristics. These are set forth and their relative merits and demerits are discussed.

Soil sampling for laboratory examination is the next step after soil site and soil profile characteristics are determined. The method of taking soil samples from the field is described.

The information gathered in the field is placed on permanent record by means of a soil map. The procedure of preparing a soil map is briefly outlined.

Methods of soil survey differ slightly in different countries, but the general principle of all the methods is the same. Soil survey systems in Bavaria, Hungary, Russia, America, and England are described in some detail in the final chapter.

#### SOIL EROSION AND ITS CONTROL.

Ayres.

Soil erosion has become a widespread menace in America. According to an estimate framed in 1935, 35 to 50 million acres of cultivated land are now totally ruined and abandoned as compared to 10 million acres in 1910. Partial to complete stripping of topsoil on 100 to 125 million acres of the remaining cultivated land is estimated. Potentially an area exceeding one third of the entire cultivated acreage of the United States is either totally ruined or will soon be totally ruined unless vigorous and unrelenting attack on the menace is resorted to. This book is a general treatise on erosion control in which an attempt has been made to introduce and correlate all phases of this complex problem.

The three most active eroding forces are water, wind, and ice. Factors affecting rate of erosion are :—rainfall and runoff, soil characteristics, vegetation, and land slope. The effect of these factors on erosion are discussed. The relative value of the different farm crops in preventing soil loss is brought out clearly. The method of making

a quantitative determination of run-off from rainfall intensity is explained and graphs giving the run-off for different forest cover and different catchment areas are given. Methods of control on slopes suitable for cultivation and on gullies are discussed in detail. Some of the methods of erosion control on slopes are :—contour farming, strip cropping, terrace cultivation, and planting of pastures. Terracing is dealt with in great detail. Design of terraces, spacing, grading, planning and layout, surveying procedure, terrace construction methods and machinery, terrace costs and maintenance and terrace outlets, are fully treated. Several useful tables for terrace design are included.

**Check** dams for erosion control in gullies are usually of a temporary character and serve to hold the fill and prevent washing while vegetation for permanent control is becoming established. The design of these check dams is described. For gullies draining watersheds of considerable size, permanent dams are suggested. Various types of masonry and concrete dams are discussed and tables for their design are given. Types of earth dams used are also described. Bank protection of streams and rivers to prevent caving, and bank protection methods in use are described and illustrated. Special use of vegetation and trees in gully control is explained, and suitable species of trees are mentioned.

To secure research data for various erosional areas in the United States, 13 experimental farms have been established. A list of experiments being conducted at one of them is given as a typical example of the work being done at these stations. It is explained how a tentative plan of farming with a view to soil conservation can be arrived at, and a conservation farming programme to serve as a rough guide is set forth.

#### STORAGE RESERVOIRS.

Williams.

The author in the Preface says : "Many excellent works have been written on the subject of dams and reservoirs but most of them are now out of date. In recent years, enormous structures have been made possible by new methods of design and improved materials. There is obviously room for a treatise that deals with these modern developments".

This book deals with the design and construction of dams and reservoirs. It commences with a chapter on rainfall in which the cause of rainfall, the monsoon, maximum intensities of rainstorms, and the rainfall characteristics

of India, Ceylon, the British Isles, Hawaii and the United States of America are discussed. The next chapter deals with run-off and storage capacities. Several methods of computing run-off are described. The practical method of calculating storage capacity is dealt with in some detail and as an illustration an actual example in India is worked out. The question of evaporation and percolation losses from reservoirs is also discussed.

Chapter 3 describes methods of estimating maximum rates of flood flow for various catchments. Formulae for maximum probable rates of flood discharge in various countries are given. The design of spillway capacity for storage reservoirs is treated in detail.

The next four chapters are devoted to the design of various types of dams such as gravity dams, single arch masonry dams, multiple arch dams, reinforced concrete dams, earth dams, and hydraulic and rockfill dams. Relative economic of various types of dams is discussed. Important dams of recent construction are briefly described as well as some which are in course of construction. The principles of design of various types of dams are set forth and a number of useful stress diagrams are included. A comprehensive list containing details of various types of existing dams is given.

A chapter on regulation of storage, reservoir outlets, power stations, irrigation intakes, overflows, and siphon spillways, deals with sluices, automatic spillways, gates of various types, needle valves, and outlets from reservoirs. Arrangements of power stations and surge tanks for hydro-electric schemes are discussed. Two power schemes are described in some detail, namely the Galloway water power scheme, and the Le Sautet scheme in France.

In construction several problems present themselves such as, housing the workmen, disposal of surface flow during construction, disposal of floods, cementation of foundations, and problems connected with mass concrete construction. The methods of detling with such problems are discussed with special reference to some recently completed dams such as the Boulder Dam, the Cauvery Mettur Dam, and the Grinsel Dam.

The chapter on the treatment of water from storage reservoirs used for domestic supplies will be found useful by sanitary engineers.

The final chapter describes a tour round some of the dams and reservoirs of Great Britain.

**REINFORCED CONCRETE ARCH DESIGN.**

Manning.

This book contains new and exact mathematical solutions of problems of various types of reinforced concrete arches. The first seven chapters are devoted to theoretical treatment of problems connected with the symmetrical and unsymmetrical encastre arches, two hinged arches with tied and free ends, and continuous arches on flexible supports. Yielding and sinking of abutments, live and dead load effects, temperature and crown drop effect, spandrel load stresses, and methods of design are dealt with in great detail. Tabulated values are given showing the moment, thrust and shear caused by a load placed anywhere on any kind and shape of arch of any thickness. Some practical considerations affecting the design or selection of any particular type of arch, shrinkage, working stresses, etc., are discussed in one chapter. Three chapters are devoted to the complete design of two encastred and one two-hinged tied arch of 60 ft., 130 ft. and 100 ft. span respectively. In the last two chapters the author deals with the general size and shape of solid abutments in so far as these affect the design of the arch they support, and the general stability of piled abutments. The book offers a complete guide to the designer from the cross section of the gap to be bridged to the details of the reinforcement, and if the method of design outlined is followed step by step, it will give the most economical shape and thickness of arch in any given case.

**THE FEDERATION OF INDIA.**

Lele.

This book is a summary of the Government of India Act of 1935 presented in a simple and general way so as to be helpful to the general public in acquiring a substantial appreciation of the Act.

**BUILDING CONSTRUCTION FOR YOUNG ENGINEERS.**

Khanna.

This book is intended to be a guide to the engineer in the field who is engaged in building construction and gives some practical and sound rules to facilitate rapid determination of dimensions of foundations, walls, floors, roofs, beams, stairs, doors and windows, etc. A chapter on building materials contains a general description of the materials in common use and their characteristics. In the brickwork and masonry section several types of masonry are described. In the chapter on ventilation, a method is given for the determination of the area of the fresh air inlet from theoretical considerations of the quantity of air inhaled and exhaled by each human being



and the volume of carbon-di-oxide produced. Miscellaneous hints include instructions for the design of fire-places, drains, and wells and means of dealing with roof leakages. Some general considerations to be kept in view in house planning are also discussed.

**THE PHYSICS OF SOLIDS AND FLUIDS WITH RECENT DEVELOPMENTS, PART II.**

Prandtl.

This book on hydrodynamics and its applications by the world famous expert on aero-dynamics contains a complete treatment of the subject including a discussion of recent developments. The first chapter deals with equilibrium of liquids and gases and discusses properties of liquids, theory of stresses, distribution of pressure in a liquid, and equilibrium of liquids. The second chapter deals with the dynamics of frictionless fluids and contains a mathematical discussion of Bernoulli's theorem, motion of a frictionless fluid, momentum theorem for flow, waves on the surface of a liquid and the flow of water in open watercourses. The third chapter deals with the motion of viscous fluids, turbulence, fluid resistance, and practical applications of the theories developed to propellers, windmills, water turbines, ships and aircraft. Viscosity, Reynold's number, the theory of boundary layers, turbulence, eddy formation and its prevention are discussed at length. Flow through straight pipes and watercourses of constant and varying cross sections is treated mathematically and the various practical applications of the types of flow discussed are described. The problems of flow in the cases of ship's propellers, windmills, water turbines, and pumps are analyzed, and the main features of the latest hydrodynamical theory of the turbine problem are discussed. The last chapter is on the dynamics of gases, and represents the latest developments on the subject.

**NOTES ON THE DESIGN AND CONSTRUCTION OF FALLS FOR THE KARACHI SCHEME DISTRIBUTARIES.**

Reprint from the Transactions of the Engineering Association of Ceylon.

Kennedy.

This pamphlet contains a general discussion of the function of falls, their location, control and regulation at falls, protection of the channel and essentials of fall design. The design of notched falls are dealt with in detail and a complete design of two notched fall built by the author is given. Calculations for weir falls, fall with plank crest between two vertical walls and a fall with sluice gate control are embodied in a number of appendices.

**COPY OF A LETTER, DATED 2ND AUGUST 1937, FROM  
MR. KENNEDY, DIRECTOR OF IRRIGATION,  
CEYLON, TO MR. GERALD LACEY AND THE  
LATTER'S REPLY THERETO.**

Mr. Kennedy informs Mr. Lacey that the Lacey Regime Theory has been adopted in Ceylon in remodelling old channels and constructing new ones, and the improved regime already recorded is an irrefutable testimonial to their practical soundness. He goes on to say that though they have adopted Mr. Lacey's principles there is an element of uncertainty about the selection of the value of "f" the silt factor. They adopt a value of "f" not exceeding 1 and allow a certain degree of latitude as regards choosing a lower value so as to permit the most economical adjustment of the other factors concerned. He explains the reasons of this procedure of selecting a silt factor adopted in Ceylon. He also enquires from Mr. Lacey whether the silt factor depends solely on the size of the silt particles and not on the specific gravity of the silt material.

Mr. Lacey in reply expresses his agreement with the reasoning on which the selection of silt factor has been based in Ceylon and says that the hit and miss principle by which they adopt a working silt factor in Ceylon is better than any ultra scientific method based on silt size alone. He considers that the weight of the silt particles undeniably affects the hydraulic conditions.

**STATEMENT FROM SIND COMPARING DISCHARGES BY  
CURRENT METERS AND VELOCITY RODS.**

The statement shows that discharges obtained by velocity rods are usually higher than those obtained by current meters, the percentage difference varying from 1.46 p. c. to 9.7 per cent. in some cases.

**STABILITY DIAGRAM OF PARICHA WEIR IN THE  
UNITED PROVINCES.**

The weir is of masonry and is 31 ft. high with a base width of 34.5 and top width of 12 ft. The upstream face of the weir is an arc of a parabola and the downstream face is a straight line with a batter of 7.5 ft. in 31 ft.

**AGRICULTURAL DATA OF SUGARCANE AND COTTON IN  
RELATION TO RAINFALL AND IRRIGATION IN  
ANAKAPALLE AND COIMBATORE AGRICULTURAL  
RESEARCH STATIONS IN THE MADRAS PRESI-  
DENCY 1936-37.**

Sugarcane of the J. 247 variety was planted on 15th, and 16th April 1936 and harvested on 26th, 27th and 28th April

1937 on sandy loam soil at the Anakapalle research station. The statement shows the dates of application and quantities of irrigation and rainwater to the crop from planting to harvesting, the mean monthly temperature and the yield obtained. A similar statement is included for Cambodia cotton sown on 20th September 1936 at the central farm, Coimbatore the soil being heavy loam with gravelly subsoil.

**AGRICULTURAL DATA OF COTTON AND SUGARCANE IN  
RELATION TO RAINFALL AND IRRIGATION IN  
RISALEWALLA AND LYALLPUR AGRICULTURAL  
FARMS, PUNJAB, FOR 1936-37.**

These statements show the results of watering experiments carried out at the two agricultural farms. The dates of application and quantities of irrigation and rain water, and the yield and other details are given. The sugarcane experiments were carried out with several varieties.

**AGRICULTURAL DATA OF COTTON AND SUGARCANE IN  
RELATION TO RAINFALL AND IRRIGATION IN  
MADRAS PRESIDENCY 1935-36.**

The statements show details of quantity of water supplied, and the yield for CO 313 sugarcane and Cambodia cotton in connection with irrigation experiments carried out in the Madras Presidency in 1935-36.

**AGRICULTURAL DATA OF SUGARCANE AND MAIZE IN  
RELATION TO RAINFALL AND IRRIGATION IN BIHAR  
FOR THE YEAR 1935-36.**

The statements show the quantity of water used and the yield of sugarcane and maize in Bihar in connection with water requirement experiments.

**STATEMENTS SHOWING THE MONTHLY DISTRIBUTION  
OF RAINFALL MEAN MONTHLY TEMPERATURE AND  
THE OUTTURN PER ACRE OF COTTON CROP ON  
THE GOVT. EXPERIMENTAL FARMS AT AKOLA  
AND NAGPUR FOR 1935-36 AND OF SUGARCANE  
AT GOVT. FARM DRUG, BILLASPUR AND  
WARASEONI FOR THE YEARS FROM 1930-31 TO  
1935-36.**

**AGRICULTURAL DATA ON MAIZE GROWN UNDER  
IRRIGATION IN THE CANAL TRACT OF THE  
SOUTH CENTRAL DIVISION AND ON THE ARBHAVI  
FARM IN THE BOMBAY PRESIDENCY FOR THE  
YEARS 1922-26.**

The statements show the quantity of water applied, the mean monthly temperature and the yield obtained.

**TWO STATEMENTS SHOWING SUGARCANE VARIETAL  
EXPERIMENTS CONDUCTED AT THE LYALLPUR  
AGRICULTURAL FARM, PUNJAB FOR 1935-36.**

The statements show the quantity of irrigation and rain water applied, the mean monthly temperature, and the yield for various types of sugarcane experimented upon.

**STATEMENT SHOWING SUGARCANE IRRIGATION EX-  
PERIMENT, SHAHJAHANPUR, U. P. 1935-36.**

The statement shows the quantity of water applied, the mean monthly temperature and the yield obtained.

**AGRICULTURAL DATA OF SUGARCANE AND COTTON IN  
RELATION TO RAINFALL AND IRRIGATION IN  
THE PUNJAB PROVINCE FROM 1930-31 TO  
1934-35.**

The statements show the result of watering experiments carried out at Risalawalla and Lyallpur agricultural farms. The total quantity of water used and the yield obtained are given. The sugarcane experiments were carried out with several varieties.

**AGRICULTURAL DATA OF SUGARCANE AND COTTON IN  
RELATION TO RAINFALL, IRRIGATION, ETC., IN  
THE MADRAS PRESIDENCY FOR THE YEAR 1932  
TO 1935.**

The statements show the quantity of water used and the yield of Cambodia cotton and sugarcane as observed in the Madras Presidency.

**FLUVIAL MORPHOLOGY IN TERMS OF SLOPE, ABRA-  
SION, AND BED-LOAD. Reprint from Trans-  
actions of the American Geophysical Union,  
Seventeenth Annual Meeting 1936.**

Shulits.

Fluvial morphology is defined as the science of the forms of river beds, their shapes in plan and profile. Existing knowledge with regard to the phenomenon of meandering of streams and changes of profile of streams is generally qualitative but there are some universal quantitative principles of fluvial morphology that have been developed theoretically. The object of this paper is to present firstly a brief statement of some of the qualitative observations

and secondly a more detailed statement of several quantitative laws and their use. Some of the qualitative observations are formulated below.

1. The cause of meandering of rivers is the existence of a slope exceeding that required to transport the fine material composing the bed-load. The river flattens its course by meandering.
2. A cut-off results in degradation above the cut-off and aggradation below it.
3. Reduction in bed-load induces a decrease in slope.
4. The river width increases downstream. Investigations of several hundreds of cross sections led Schoklitsch to conclude that the width increases along the stream in direct proportion to the six-tenths power of the yearly run-off.

Some rational morphologic laws are then discussed mathematically, and a number of equations are developed relating bed-load material and abrasion; size of bed-load material and slope of river bed; and bed-load, drainage area, run-off, and abrasion along the course of a river. Schoklitsch's bed-load formula is also discussed. The effects of a river cut-off are analyzed in detail and it is mentioned that the results of the theoretical analysis have been verified frequently in actual practice.

WATER-LOSSES IN HIGH LATITUDES AND AT HIGH ELEVATIONS. Reprint from Transactions of the American Geophysical Union, Fifteenth Annual Meeting, 1934.

Horton.

Water losses may be divided into three parts: (1) rainfall interception; (2) transpiration by vegetation; (3) evaporation from the soil. In high altitudes the main source of water loss is evaporation. Some of the salient points, and unsolved problems concerning water losses at high altitudes are outlined in this paper with reference to a number of data of actual observations of losses in a number of basins in the U. S. A. The author has derived an evaporation formula and has explained its use. Evaporation from and condensation on snow and ice, and experiments carried out in this connection are discussed.

**AN EXAMPLE OF LONG-RANGE FORECASTING OF PRECIPITATION ON A DRAINAGE-AREA.** Reprint from Transactions of the American Geophysical Union, Seventeenth Annual Meeting, 1936.

Shulits.

By the method of partial correlations, W. Von Kesslitz has ascertained the relation between the monthly precipitation on the drainage area of the Teigitsch creek in Styria, Austria, and the monthly mean of temperature and barometric pressure for preceding months in the three atmospheric centres of action governing Europe, namely, Iceland, the Azores and Siberia. He has derived correlation equations for precipitation on the Teigitsch drainage area which are reproduced. The computations required several years. The agreement between observed precipitation and that predicted with the aid of the equations is good. He has further prepared equations for the run-off of the drainage area at the Langmann dam by using the correlation method wherein the run-off is related to the rainfall.

**THE SCHOKLITSCH BED-LOAD FORMULA.** Reprint from "Engineering", June 21 and 28, 1935.

Shulits.

The solids transported by a stream consist of suspended matter and other material carried along the bed. The coarser material which is carried along the bed by traction is termed the bed-load. A study of laws governing bed-load is important because it affects the regimen of a river. The erection of a dam in a solid-carrying stream results in aggradation of the bed upstream of the reservoir created, and the regimen of the stream is upset. The Schoklitsch bed-load formula which is considered in this article serves to compute that portion of the total solids load of a river which is transported along the river bed by the tractive force of the stream. The formula states that the bed load quantity moved per unit of time is proportional to the so-called effective discharge which is the difference between the instantaneous discharge and the critical discharge. The rational basis of the formula and the steps leading to its derivation are explained, and the method of determination of the co-efficient in the formula is described. The formula has been verified in the laboratory and in actual streams, and details of these verifications are mentioned. Though developed solely for uniform grain material, the applicability of the formula to mixtures is shown in the article.

**FLOW NETS FOR SOIL-SEEPAGE PROBLEMS.** Reprint  
from "Engineering", August 17, 1934.

Shulits.

This article is a brief statement of Continental European practice in the use of "flow nets" in seepage problems dealing with the methods developed by Forchheimer and Schoklitsch. The network of lines everywhere perpendicular to each other obtained by drawing the stream lines of flow and the equipotential lines or the lines of equal piezometric levels is called a "flow net". The graphical representation of the "flow net" is first explained and an equation representing the law of flow through the net is derived.

The process of determining seepage under a dam by the "flow net" method is then described in detail and another application to a sheet pile cut-off wall is illustrated.

Dachler has used the "flow net" method to compute the seepage from canals and has checked his results experimentally but details of his methods are not given in this article.

**THE AQUATIC WEEDS IN DECCAN IRRIGATION CANALS.** Reprinted from the journal of  
Ecology, February 1928.

Narayanayya.

The serious blocking of irrigation canals in the Bombay Presidency by aquatic weeds led to a study of the weeds and the conditions of their growth since 1915. This pamphlet presents results of the study. The studies concern three important canals of the Deccan canal system namely the Mutha Right Bank Canal, the Nira Left Bank Canal, and the Pravara Left Bank Canal. An idea of the blocking may be had from the fact that the Mutha R. B. Canal discharge dwindles down to 95 cusecs from 420 cusecs when it is full of weeds. The weeds are described and their characteristics are given. The effect of silt in suspension and deposition of silt on the growth of the various weeds is discussed. A section of one of the canals was thoroughly cleared and the sequence of silt deposition and weed growth was studied in the cleared portion. The results are given. Some of the conclusions arrived at are :—

1. Presence or absence of weeds is determined by the deposition of silt.
2. Effect of silt in suspension is not proved. Comparative poverty of aquatic flora in silt laden water can be better correlated with greater velocity and less deposition of silt.

**NOTE ON SOIL AMELIORATION AND WATER REQUIREMENTS OF CROPS IN BENGAL.**

Gupta.

Mr. Sen Gupta discusses the fertility of silt in Bengal rivers. The silt of the North Bengal rivers is not so fertile as that of the West and South Bengal rivers. Means of distribution of river silt over cultivated lands in Bengal are discussed. Improvement of soil in Bengal may be effected by deposition of fertilizing silt, application of artificial manure, an improved crop rotation programme and leaving fields fallow.

In the second part of the note Mr. Sen Gupta stresses the need of a study of water requirements of rice as influenced by a change of date of sowing. This study would enable a suitable adjustment of the date of sowing, so that it may be possible to grow both kharif and rabi crops in Bengal instead of only one crop as is usually done in Bengal. A study of suitable crops for introduction in Bengal, their water requirements and economic value is necessary.

**BRIEF NOTE DATED 19TH JUNE 1937 TO ACCOMPANY DRAWINGS AND HYDRAULIC CALCULATIONS OF A PROPOSED SILT EXCLUDER ON THE UPPER BARI DOAB CANAL.**

Montagu.

This note describes the hydraulic design of a silt excluder which was proposed for the Upper Bari Doab Canal. The general considerations of design are discussed and detailed calculations and drawings of the silt excluder are attached.

**FORMULA REGARDING BACK WATER CURVE AND DRAW DOWN CURVE, 11TH MARCH 1932.**

Burkitt.

A formula for backwater and draw down curve has been worked out for trapezoidal or rectangular channels, and the use of the formula has been illustrated by examples.

**COPY OF A LETTER DATED 3RD SEPTEMBER 1937 FROM THE DIRECTOR, CENTRAL IRRIGATION AND HYDRO-DYNAMIC RESEARCH STATION, POONA, TO SUPERINTENDING ENGINEER, NORTHERN SIND CIRCLE, KARACHI, REGARDING "EXPERIMENTS WITH A MODEL OF THE TANDO MASTIKHAN FALL".**

Some experiments were carried out with a 1/16 scale model of the Tando Mastikhan Fall to determine the discharge gauge relationship. The gauge discharge relationship obtained for the model and for the prototype are given and a graph showing correlation between discharge and gauge in model and prototype is attached.



**DROUGHT HAZARD OVERCOME IN ARIZONA IRRIGATION PROJECT WITH PUMPS.** Reprint from

"Western City", August 1936.

Hornberger.

Describes some features of an important installation of deep well turbine pump units to provide an auxiliary supply of water for the San Carlos Irrigation Project in Arizona. The scheme consists of 74 wells drilled and equipped with pumping plants. All the wells drilled are 20 inches in diameter, with an average depth of 239 ft. The minimum depth is 154 ft. and the maximum is 480 ft. The wells are all cased with double stove-pipe casing which was perforated after installation. Each pump was intalled in a small circular sheet steel pump house. Pump specifications, efficiency evaluation, and shop and field tests of the equipment are discussed.

**SPECIFICATION NO. 1—REINFORCED CEMENT PLASTER LINING.**

Edgecombe.

Describes the procedure to be adopted for lining a watercourse or a channel with  $\frac{3}{4}$  inch thick layer of reinforced cement plaster of 1 to 3 mix.

**COPY OF LETTER NO. 4260, DATED 13TH AUGUST 1937 FROM MR. C. E. AITKEN, SUPERINTENDING ENGINEER, DECCAN IRRIGATION CIRCLE, POONA, TO THE SECRETARY, CENTRAL BOARD OF IRRIGATION REGARDING "GUNITE LINING".**

Information regarding the Gunite lining done to the approach channel in Mile 1 and cutting in Mile 7 of the Nira Right Bank Canal is furnished in this letter. The lining was carried out to stop leakage. The gunite consisted of equal parts of fine sand and hydraulic lime which were shot by an air compressor. Actual saving in percolation is not known.

**REPORT ON THE SLIPS IN THE EARTHEN EMBANKMENTS OF THE TANKS AT EKRUK, ASHTI AND WAGHDAD IN THE BOMBAY PRESIDENCY.**

The Ekruk tank was completed in 1869 and the other two tanks in the early eighties. Since their completion, a number of slips occurred in the embankments at different times and remedial measures were adopted each time a slip occurred. This report contains a brief description of some of the serious slips from the date of completion of the embankments to the present day, discusses their probable causes, and describes the remeidal measures adopted in each case. The degree of success achieved with the present remedial measures is discussed.

**CORRESPONDENCE REGARDING LINING OF HAVELI  
MAIN CANAL WITH SODIUM CARBONATE.**

Mr. J. D. H. Bedford, Chief Engineer, Punjab, requested Dr. McKenzie-Taylor, Director, Irrigation Research Institute, Punjab, to write a note on the application of sodium carbonate treatment on a large scale in view of the proposed adoption of the process in lining the Haveli Main Canal. Information was called for particularly on the following points :—

- (1) Organizing the work.
- (2) Method of application when the soil suitable for treatment exists at site or has to be rehandled.
- (3) Definition of clay and method of differentiating it from loam at site.
- (4) The actual process that occurs when sodium carbonate makes the soil watertight.
- (5) The durability of the process with actual instances if any.
- (6) Effect of canal water on the lining.
- (7) Wholesale source of supply of soda and the price and quantities required.

Dr. McKenzie-Taylor in reply says that the first step to be taken is a soil survey of the canal alignment to a depth of 2 ft. below designed bed level to determine the reaches suitable for treatment. He states some general rules regarding the relation of soil type and treatment. He then describes in detail the procedure to be adopted in applying the sodium carbonate when the soil suitable for treatment, that is to say, with 15 to 10 per cent. of clay content exists at site, and when the soil with the necessary clay content has to be placed in the bed after removing the soil unsuitable for treatment. As regards differentiating clay from loam, what is required is the determination of the percentage of particles in the soil below .002 m.m. in diameter, which can be done by a hydrometer. Dr. McKenzie-Taylor then describes the staunching process and mentions that sodium clay is one of the most stable compounds found in nature and there is no better evidence of its durability. The action of canal water on the lining will be negligible for all practical purposes. He suggests that the quantity of sodium carbonate required should be estimated at 100 lbs. per 1,000 sq. ft. of area to be treated. In conclusion, he points out that the treated clay behaves like a jelly and is elastic. Being flexible it will assume the conformation of the underlying soil and is therefore superior to a cement lining.

COPY OF A LETTER DATED 4TH AUGUST 1937 FROM  
 JOSE GARCIA MONTES, DIRECTOR OF INDUSTRIES  
 CUBA, TO THE SECRETARY, CENTRAL BOARD OF  
 IRRIGATION, REGARDING RAINFALL, CROP PRODUCTION  
 AND WATER REQUIREMENTS OF CROPS.

The writer outlines a method developed by him which aims to "express numerically the concept of the efficiency of rainfall as applied to different crops". The benefit of rainfall depends on its absolute amount, its intensity and its opportunity. The amount and intensity are capable of numerical expression but the "opportunity" has never before been expressed numerically. The writer's method gives the "opportunity" of rainfall a numerical expression. For this purpose, the standard water requirements of a crop are first established from sowing to harvesting and correlated to the rainfall as recorded over the same period and a method of statistical analysis is applied to the data. The result obtained is a cypher which takes account of the amount of rainfall as well as its opportunity to the crop and is termed the index of effectivity by the writer.

#### SOME ASPECTS OF THE TURBULENCE PROBLEM.

Reprint from "Mechanical Engineering",  
 July 1935.

Karman.

The application of rational hydro-dynamics to technical problems is handicapped by the fact that in technical problems the apparently steady motion of fluids is really turbulent, that is to say, subject to irregular fluctuations of velocity and pressure. For technical hydrodynamics, a real theoretical foundation is only possible on the basis of an understanding of turbulent motion. The subject of this article is to review the extent of the present knowledge on turbulence research and especially to review the practical problems connected with this research which may be enlightened by new knowledge in this field. The writer outlines the development of turbulence research from the early empirical methods to the discovery by Reynolds of the laws and fundamental facts of turbulent flow, and the part played by dimensional analysis in the furtherance of this research. He then presents an analysis of turbulent fluid motion by the Enlerian method which considers pressure and velocity at a given point and the Langrangian method which considers the fate of an individual particle, and derives a number of equations representing the theory of turbulent flow. Some practical applications of the concepts are then dealt with which include flow in a closed conduit, flow in rough conduits, flow of a free stream along a surface, effect of turbulent friction on dissipation

of velocity differences, problem of heat transfer between a solid and a fluid, and the problem of the distribution of transported sediment through the cross section of a river or a channel

CIRCULAR DATED 8TH SEPTEMBER 1937 FROM THE  
ENGINEER-IN-CHIEF, ARMY HEADQUARTERS,  
SIMLA, TO THE CHIEF ENGINEERS OF ALL COM-  
MANDS, REGARDING "GROUND BEARING TESTS—  
FOUNDATION DESIGN."

A test sheet has been prepared and experiments are ordered to be carried out on the lines laid down. The test sheets are to be completed after carrying out the experiments and returned to the Engineer-in-Chief. From the results of the experiments a table is to be prepared giving the safe bearing strength for average sites in all military stations in India for inclusion in later editions of the M. E. S. Handbook.

THE ECONOMIC IMPORTANCE OF CHANGES IN PLANT  
COVER. Reprint from the Journal of the Indian  
Botanical Society, Vol. XVI, No. 4, 1937.

Gorrie.

This paper was presented to the Botanical section of the Indian Science Congress, 1937. The similarity of land use problems in India and the United States of America is pointed out. In the U. S. A. the need for careful retention of plant cover on all agricultural and waste land which is not actually ploughed has been emphasized. The same holds true for India also. Of the various factors affecting plant cover, grazing is the most widespread and the most insidious. Uncontrolled grazing results in denudation of the vegetation and heavy run-off leading to erosion. Two examples are discussed which emphasize the need of maintenance of plant cover. One is the Uhl River catchment, a detailed survey of the erosion conditions, of which was carried out by the author a short time ago. He discusses the extent and cause of erosion and gives the remedies to be adopted to stop further erosion. The second example is the Pabbi Hills tract in which three distinct areas representing three types of plant cover are to be found. The area under afforestation shows a maximum flood intensity of 100 cusecs per square mile; the area of passively protected forest reserve gives a maximum flood intensity of 600 cusecs per square mile; and the area which is not protected at all and is open to unrestricted grazing gives a flood intensity of 1,600 cusecs per sq. mile. The violent and heavy discharges of these grazed areas causes prolonged flooding in the adjoining flat country and this exaggerates the already pressing problems of rising water-table in this tract.

**A "CLOSED-CIRCUIT" FLUME FOR SUSPENDED-LOAD STUDIES.** Reprint from Transactions of the American Geophysical Union, Seventeenth Annual Meeting, 1936.

Oaks.  
Knapp.

The fundamental aspects of suspended load as it affects the dynamics of a stream flow is of great importance not only to hydraulic research but also to the soil conservation service in its study of problems of erosion. One phase of the study of suspended load is the determination of its influence upon the flow characteristics of a stream. A thorough investigation was made with various types of flumes for the study of suspended load problems in the laboratory and ultimately the flume described in this paper was considered the most suitable. The design of the flume and its working are explained in detail.

**INFORMATION REGARDING THE METHOD OF STORING WATER BY NIGHT IN THE GEZIRA IRRIGATION SCHEME, SUDAN GOVERNMENT.**

In reply to a letter from the Secretary, Central Board of Irrigation seeking information with regard to the method of storing water by night in the Sudan, the Director of Irrigation furnishes some information on the subject based on methods usually adopted in the Gezira Irrigation Scheme. Night storage is only effected in the minor canals. The storage in minors is a practical possibility only because of the uniform layout adopted. The minors are spaced at equal intervals and irrigate on one side only. The field channels taking off the minors are also spaced at equal intervals and water on one side only. The area served per unit length of minor canal is constant. Accommodation for night storage water is provided by setting the banks back thus giving extra width and allowing for a rise in water level above the designed full supply level. A form of regulator is built along the minor every 2.5 kilometres thus dividing the whole length of the minor into a number of compartments. A pipe sluice is set in the wall of the regulator so that water may be passed through the sluice or over the weir at will. In the night, all outlets are closed and the pipe sluices of the regulators are also closed. The water coming into the minor is stored in the first compartment and after filling it, overflows over the regulator wall into the next compartment and so on. Typical sections of night storage canals with drawings of the regulator are given.

ENGLISH EDITION OF THE CLASSIFICATION DECIMALE UNIVERSELLE OF THE INSTITUT INTERNATIONAL DE DOCUMENTATION, VOL. I, FASC 1—AUXILIARY TABLES.

NOTE ON THE CONDITIONS THAT FAVOUR THE GROWTH OF WEEDS, ETC., IN THE ELLORE CANAL, MADRAS May, 3, 1937.

Low velocity of the canal is favourable to the growth of weeds. Moreover when the water is clear and the sun's rays can penetrate easily the rate of growth of weeds is more than when the water is muddy. Weeds are cleared by manual labour periodically and it has been laid down as a rule that silt should be periodically cleared during canal closure so that weeds may be dug up from the roots. Experience has shown that clearance to a depth of 8" to 12" is necessary to get at the roots.

INFORMATION ABOUT THE LEAK IN THE FOUNDATION OF THE LLOYD DAM AT BHATGAR. April 1937.

A leak was discovered in the foundations of the dam between the red and black rock met with. Both the rocks are trap rocks but the red rock is somewhat of a coarser nature and is found to deteriorate on exposure to the air. It has also a tendency to split up layers of harder rock above it.

To prevent any possibility of up-ward pressure due to this leak, it is collected into a drain and is given an outlet on the downstream side and a cut off trench is also provided on the upstream side.

WEEDS ON CANALS IN SIND. (Copy of letter No. G-8, dated 24th May 1937 from the Executive Engineer, Southern Dadu Division, to the Superintending Engineer, Western Sind Circle).

Mathrani.

Gives his experience of pan grass (*Typha elephantia*).

Says that this weed grows in clear, shallow and slow moving water and it propagates both through the roots and the seed. Describes experiments with broadcasting "Lari" rice on the berms of the channels for preventing weed growth and says that in the very first year the weed growth was reduced to less than fifty per cent., in the second year to 20 per cent. and in the third year to 10 per cent. Another method for preventing weed growth is given, i.e., to dry the channels, plough them deep, turning over the roots and exposing them to the sun for a few months.

Experiment on the reduction of weed growth on the Main Nira Valley Drain by widening the channel is also described.

POCKET EDITION OF GENERAL CATALOGUE ON WATER/WORKS FITTINGS BY GLENFIELD & KENNEDY, LTD.  
LONDON.

AN UP-TO-DATE SET OF PAMPHLETS ON WATER WORKS FITTINGS BY GLENFIELD & KENNEDY, LTD.,  
LONDON.

LEAFLETS REGARDING PLUMBITE: A MANUAL ON  
PIPE JOINTING.

Borthwick.

CATALOGUE ON CHEMICAL CONSOLIDATION AND  
GROUND-WATER LOWERING BY JOHN MOWLEM &  
CO., LTD., LONDON.

LEAFLETS ON ALPASTE PARA PROTECTION BY  
ALUMINIUM UNION OF CANADA, LTD.

ELECTRICAL CONDUCTORS HANDBOOK ISSUED BY  
ALUMINIUM UNION OF CANADA, LTD.

## MAPS, BLUE PRINTS AND PHOTOGRAPHS.

### *Bengal.*

Damodar Canal—Tracing of Anerson Weir, showing Franki concrete pile and steel sheet pile lines.

### *United Provinces.*

Ganges Canal—Two photographs of the Tramway Project.

Ganges Canal Hydro-Electric Scheme—Five photographs in connection with the Nirgajni Power House.

Ganges Canal Hydro-Electric Scheme—Four photographs of the Chitaura Power Station.

### *Punjab.*

Haveli Project—Design of a proposed fall at R. D. 1800 of the Multan Branch. (This is Mr. C. C. Inglis' design).

### *Bombay.*

Shirwata Dam—Stability diagrams. (2 drawings).

Walwahan Dam—Stability diagram.

Takerwadi Dam—Stability diagram.

Mulshi Dam—Stability diagram of the revised section of the dam.

Lloyd Dam—Stability diagram. (3 drawings).

Wilson Dam—Stability diagrams.

### *Sind.*

Two photographs in connection with weeds on canals in Sind.

*Indian States.**Karauli State.**Map of Karauli State.**General.*

Plan of major levee system along the Mississippi river.

Diagram by Mr. J. S. Kennedy, Director of Irrigation, Ceylon, of Regime Channels by Mr. Gerald Lacey's formulas. July 1934.

## NEWSPAPER CUTTINGS.

## IRRIGATING KHYBER AGENCY: CONSTRUCTION OF

DAM: SCHEME SHELVED FOR FINANCIAL REASONS. 4th July 1937.

Mentions the opinion of the Geological Survey of India on the suitability of the site for the proposed Jaba-Tanga Irrigation Scheme in the Frontier Province. The scheme comprises the construction of a diaphragm wall or an impervious dam across a narrow rock gorge about 250 ft. wide, through which the Khyber river debouches. The rock bed at this gorge is covered by about 30 ft. of bajri sand, shingle and boulders. It was also calculated that there was a subsoil water flow of 50 cusecs and a minimum discharge of 25 cusecs was assumed. The opinion of the Geological Survey of India was sought as to whether the rock was staunch enough for the purpose. Dr. Coulson, who was deputed for the investigation, has given his opinion that the site selected is as good as any other in the gorge.

## GUJRAT VILLAGERS' SELF-HELP: DEFLECTING

TORRENT INTO ITS OLD BED. 5th July 1937.

Twenty years ago the 'Dwara Kas', a tributary of the Chenab, left its channel about 5 miles above its junction with the Chenab river and cut a fresh channel through the lands of 14 villages, destroying in the process about 6,000 acres of good agricultural land. The villagers, not getting any help from any source, have banded together to supply free labour in the building of an earth bund which it is hoped will deflect the torrent back into its old bed again. The scheme consists of a main bund, some 600 ft. long by 14 ft. high, with 4 spurs of groins which point out into the sandy torrent bed in order to deflect the force of the torrent away from the main bund. The faces exposed to torrent action have to be revetted with a layer of sand bags, and a considerable amount of planting is being done with shisham trees, banha bushes, kana grass clumps, and agave or Spanish bayonet plants in order to bind the sandy soil on and around the bund.



**CHIEF ENGINEER RETIRING : FAREWELL PARTY AT  
SIMLA. 6th July 1937.**

Rai Bahadur Bawa Natha Singh, Chief Engineer, Irrigation, Punjab, retired from service, in the first week of July.

**RAISING OF DAM AT BIJAPUR : SCARCITY RELIEF  
MEASURE. 6th July 1937.**

The raising of a dam of the Bhutnal Water Works, Bijapur, has been undertaken by the Municipality as a scarcity relief measure. It will cost about Rs. 78,000 and will provide labour for 1,000 people a day for a year.

**PUNJAB ASSEMBLY : BHAKRA DAM SCHEME : WHEN  
IT WILL BE EXECUTED. 10th July 1937.**

Questions and answers in the Punjab Assembly, about the commencement of the Bhakra Dam Scheme.

**TIMBER FOR HEAVIER STRUCTURES AND SAFER  
HOUSES. 11th July 1937.**

An article by J. N. Zutshi, B.Sc. (Lond.), A.C.G.I., Member of the Iron and Steel Institute, London. Describes the advantages of timber as compared with steel as engineering materials. Besides its usefulness in bridges and houses, he describes its utility in constructing dams of timber.

**MANDI SCHEME EXTENSION : BULK SUPPLY TO  
DELHI ALSO. 13th July, 1937.**

Questions and answers in the Punjab Assembly about extensions of electric supply under the Mandi Scheme.

**HYDRO-ELECTRIC SCHEME FOR SIND. 14th July,  
1937.**

The Sind F. W. D. have now in hand a Hydro-electric scheme, under which it is proposed to generate electrical energy at Tando-Mastikhan Fall on the Rohri Canal. The scheme is estimated to cost Rs. 10 lakhs.

**SHORTAGE OF FODDER IN U. P. : GOVT. LOWERS  
IRRIGATION RATES. 15th July, 1937.**

To encourage cultivation of fodder, clovers, and grasses, Government have decided to lower the irrigation rates for such crops on certain canals.

**TUNGABHADRA PROJECT : SETTLEMENT HOPES. 20th  
July, 1937.**

The favourable discussions between the representatives of the Madras and Hyderabad Governments, have raised a hope that the controversy will be settled.

**DOABA M. L. A.'s. DEMANDS : RAISING OF WATER  
LEVEL : SUGGESTION TO BUILD DAM IN SIWALIKS.  
20th July 1937.**

The necessity of devising measures to meet the growing menace to agriculture in the Hoshiarpur and Jullundur districts owing to continuous subsidence of the water-level in the Doaba wells was urged by a deputation of the Punjab Doaba M. L. A's. which waited on the Premier and the Revenue Minister. The deputation urged that a dam be constructed in the Siwalik hills to collect flood water during the rains, which would stop the devastation of floods and facilitate irrigation during the dry season.

**PROPOSED LLOYD BARRAGE PROJECT FOR KHAIRPUR.  
21st July, 1937.**

A proposal for a Lloyd Barrage Project for Khairpur State, by which 106 miles of new canals will be constructed and the existing 651 miles of canals remodelled, is understood to have been forwarded to the Govt. of India for sanction. The project is estimated to cost Rs. 69,32,835 and is expected to irrigate about 9,40,230 acres of land.

**IRRIGATION PROBLEMS : RESEARCH COMMITTEE'S  
WORK. 21st July, 1937.**

Refers to the Research Committee meeting of the Central Board of Irrigation held in June. Particular mention is made of the land deterioration and reclamation experiments conducted in the Punjab Irrigation Research Institute, with special reference to waterlogging.

**PROPOSED NEW CANAL : SURVEY BEING COMPLETED.  
22nd July, 1937.**

It is learnt that a survey for constructing a canal from Tons river, near Rewa State, for the purpose of irrigating lands in the Allahabad, Rae Bareli, Partabgarh and other neighbouring districts, is being completed. The canal will be fed by lifting water 40 ft. from the river by means of electricity.

**DEPENDABLE SUPPLY : DISCUSSIONS ON TUNGA-  
BHADRA WATER PROJECT. 22nd July, 1937.**

The conference between the representatives of the Madras and Hyderabad Governments about the Tungabhadra waters scheme discussed the question of dependable supply of water at Mallapuram. The figures agreed to are given.

**WORLD NEWS BY AIR : INDIA'S POPULATION PROBLEM : PLEA FOR ASSISTED EMIGRATION. 24th July 1937.**

A brief summary of a paper read by Prof. Radhakamal Mukerjee of Lucknow University before the Royal Society of Arts in London, on Indian population and food supply.

**GOING HUNGRY. 27th July 1937.**

Editorial notes, on Prof. Radhakamal Mukerjee's paper mentioned above.

**SUBSOIL FARMING AND SUBSOIL FORESTRY : WASTEFUL CULTIVATION METHODS : WARNING AGAINST THEIR USE. 29th July 1937.**

Describes how the denudation of forests and lack of plant cover cause the washing away of the valuable top soil and leave the poor subsoil for farming and forestry, and warns against such wasteful cultivation methods.

**CENTRAL BOARD OF IRRIGATION : MEETING OF RESEARCH COMMITTEE IN SIMLA. 30th July, 1937.**

Mentions some of the important questions, including seepage from canals and their treatment, particularly with sodium carbonate, waterlogging, and design of weirs on permeable foundations, which were discussed at the Research Committee meeting of the Central Board of Irrigation in June.

**CENTRAL IRRIGATION RESEARCH CENTRE : KHADAKVASLA STATION : PROVINCIAL GOVTS., FOR CONTINUANCE. 6th August, 1937.**

The Govt. of India have decided to leave the question of continuing the Khadakvasla Research Station to Provinces and have addressed a circular letter to Provincial Governments regarding this.

**THE NEED OF PLANNED ECONOMY : TO SOLVE PROBLEM OF UNEMPLOYMENT : SWADESHI EXHIBITION AT SALEM : MR. V. V. GIRI'S SPEECH AT OPENING. 6th August 1937.**

The speaker emphasizes the necessity of planned economy and mentions the objects which such an economic planning should aim at. It includes the introduction of improved methods of agriculture and extension of irrigation.

**EROSION MENACE IN PABBI HILLS : LOSS IN REVENUE : HISTORY AND FUTURE OF RECLAMATION WORK.** 8th August, 1937.

Review of a pamphlet by Dr. R. M. Gorrie. Describes the reclamation work being done in the Pabbi Hills of Gujrat district, Punjab, and the possibility of future development. The land in this part is being eroded at a rapid pace and although earth bunds and other methods are being adopted to combat the evil of erosion, the author recommends the encouragement of a better plant cover.

**PURPOSE OF DAMODAR CANAL SCHEME : ANSWER TO CRITICS : IMPROVEMENT LEVY ON RYOTS JUSTIFIED.** 9th August, 1937.

The Govt. of Bengal have issued a Press Note justifying the imposition of improvement levy on the ryots of the area irrigated by the Damodar Canal.

**SIND ASSEMBLY : LAND ASSESSMENT IN BARRAGE AREA.** 11th August 1937.

It was suggested in the Assembly that a Round Table Conference should be held between the Government and the Zemindars to discuss the question of land settlement.

**SIND ASSEMBLY : LAND ASSESSMENT IN BARRAGE AREA : DEMAND FOR VOTING ON AMENDMENT REJECTED.** 12th August, 1937.

Two amendments were moved to the official motion to consider the report of the Settlement Officers on land assessment in the Barrage area. One amendment rejected the report and the other recommended revision, pointing out the difficulties of the zemindars paying enhanced rent.

**PHOTOGRAPH OF LAKE KHADAKWASLA.** 12th August 1937.

This lake is ten miles from Poona. The picture shows the monsoon waters rushing through the sluices of the dam.

**SECOND STAGE OF THE PYKARA HYDRO-ELECTRIC SCHEME : RAPID DEVELOPMENT IN MADRAS PRESIDENCY.** 13th August, 1937.

As the demand for electricity from the Pykara Station was more than the Station could meet, it is being supplemented by the construction of the Mukurti Reservoir. Water will be accumulated in the reservoir by the construction of a dam and then let down into the natural bed for power production. This dam—the Mukurti Dam—is 90 ft. above stream bed level. The reservoir formed will have a capacity of 1,600 million c.ft. or will give a continuous flow of 185

cusecs for 100 days. The dam is an arched masonry dam of non-overflow type designed for full uplift at points and at the head with a controlled weir 160 ft. long on the left bank. The total height of the dam above foundations is 100 ft. The visible length is 520 ft. and including the core-walls into the hill on both sides is 600 ft. Gives a description of the other engineering features of the dam, *e.g.*, foundations, determination of the safety of the foundations, drainage gallery, spillways, etc. The dam is being constructed in stages. In the first stage the dam was constructed 25 ft. high to store 230 million c.ft. In the second stage the dam is raised to 76 ft. The estimated cost of the second stage is Rs. 21½ lakhs for the whole scheme, the dam alone costing Rs. 15,24,000.

**SIND'S FINANCIAL OUTLOOK : FUTURE WORKING OF SUKKUR BARRAGE.** 13th August, 1937.

Notes on the budget estimates for Sind presented to the Sind Assembly. Detailed mention is made of the cost of construction of the Lloyd Barrage, the money loaned to Sind Govt. by the Govt. of India on this account, the possibility of paying off this debt, revenues accruing and expected from the Barrage, etc.

**MALAKAND POWER.** 13th August, 1937.

A brief account of the Malakand Hydro-Electric Scheme in the North-West Frontier Province. The Station is situated near the Malakand Pass on the heights to the north of the Peshawar Valley and depends for its running on the Swat river. It is really the outcome of the facilities created by the Upper Swat Canal Irrigation Project for the construction of a large hydro-electric power station at exceptionally low cost. The scheme is estimated to cost Rs. 65 lakhs. The work was started in December 1934 and the first stage is expected to be put into operation by the end of this year.

**HUGE AUSTRALIAN DAM CRACKED : MENACE TO NEIGHBOURHOOD :** 13th August, 1937.

The Burrinjuck Dam in New South Wales is in danger of being destroyed. At present, half the outer surface of the huge wall is wet with seepage water, the worst seepage being at a point where the wall is 80 ft. thick. There are two large vertical cracks in the wall and many smaller ones. Workmen are inserting pipes in the cracks and forcing in cement under pressure.

**IRRIGATION DUES : P. W. D. OFFICER CONVINCED  
OF FARMER'S HARDSHIPS. 14th August, 1937.**

The Minister incharge of P. W. D. Bombay has personally investigated the difficulties of the farmers and it is understood that a complete and immediate overhaul of the irrigation policy of the Govt. through changes of rates and the rules governing the collection of rent will be made.

**OCCASIONAL NOTES. 14th August, 1937.**

Mentions that the Malakand Hydro-electric scheme is nearing completion.

**IRRIGATION AND AIRCRAFT. 15th August, 1937.**

Some observations on the use of aerial surveys in engineering, which question was discussed at the Research Committee meeting of the Central Board of Irrigation held in June last.

**EXPERTS TO STUDY INDIA'S PROBLEMS DECISIONS  
AT WARDHA : SUGGESTIONS FOR THE CONGRESS  
MINISTRIES. 18th August, 1937.**

The Congress Working Committee has issued a resolution recommending to Congress Ministries the appointment of inter-provincial committees of experts to consider urgent and vital problems, like comprehensive river surveys for the formulation of policy to prevent disastrous floods, utilizing water for purposes of irrigation, problem of soil erosion, eradication of malaria, development of hydro-electric schemes, etc., the solution of which is necessary in any scheme of national reconstruction.

**CO-ORDINATION OF RESEARCH. 18th August, 1937.**

Emphasizes the need for co-ordination of research in subjects of Provincial concern in India. Particular mention is made of co-ordinating research in irrigation, recommending the establishment of a central research station. It also comments on the working of the Central Board of Irrigation and says "if the Central Board of Irrigation is financed and conducted properly, many lines of research could be carried on".

**INDIA LEADING THE WAY : 40 MILLION ACRES IRRIGATED : A WORLD RECORD : SUKKUR AND SUTLEJ PROJECTS. 19th August, 1937.**

A general note on irrigation in India, giving figures of development, outstanding features of certain projects in respect to engineering achievements, etc. (This is an official press note, copy of which is also available in this office).

**PUNJAB ENQUIRY INTO TUBE-WELL IRRIGATION.**

19th August, 1937.

The possibility of introducing tube-well irrigation in the Punjab on a large scale will be investigated by Mr. A. M. R. Montagu, formerly Secretary, Central Board of Irrigation. He has been placed on special duty in this connection.

**BENEFITS OF SARDA CANAL SILT : INCREASED OUT-TURN OF CROPS. 19th August, 1937.**

The fertility value of silt has been proved by large scale experiments carried out in the Sarda Canal area in the U. P. Certain fields were selected at 27 scattered localities and layers of canal silt, varying from one to three inches in thickness, were spread by manual labour over the fields before the crops were sown. The yield of crops on fields treated like this with that on fields having similar soil conditions but not treated with silt was compared and it was found the silt treated fields yielded 21 per cent. more in grain and 30 per cent. in bhusa.

**TRUTH ABOUT IRRIGATION. 19th August, 1937.**

Editor's remarks on the general note on irrigation development in India which has been given above.

**TUBE-WELLS AND WATER-LEVEL : ENGINEERING PROBLEM IN JULLUNDUR. 20th August, 1937.**

A hydro-electric scheme—the Jullundur Hydro-electric Scheme—consisting of five separate projects was prepared to the minutest detail but has been held up owing to the difference of opinion among engineers as to whether or not the water-level in the soil will decrease as a result of its exhaustion by tube-wells. A conference of heads of the engineering departments is being convened soon so as to reach a final decision.

**HAVELI PROJECT : WORK TO BEGIN NEXT OCTOBER.**

21st August, 1937.

Work on the Haveli Project in the Punjab is expected to commence next October. Mr. F. F. Haigh has been appointed Superintending Engineer, R. B. Ajudhia Nath will hold charge of headworks division and R. S. Lala Kanwar Sain has been appointed Director of the Central Designs Division.

**WORK WITH MODELS : INTERESTING EXPERIMENTS ON WATERWAYS. 21st August, 1937.**

Mentions some model experiments conducted at the Karachi Irrigation Research Station. These experiments include the questions of scour downstream of regulators and falls,

remodelling a regulator to be fitted with vertical screw gates in place of vertical needles, eliminating bends in canals, and providing an off-taking channel with the benefits of a cross regulator on the parent channel.

**EXTENDING TUBE-WELL IRRIGATION : INQUIRY INTO  
SYSTEM : POSSIBILITIES OF EXPANSION IN THE  
PUNJAB. 21st August, 1937.**

Mr. A. M. R. Montagu, formerly Secretary, Central Board of Irrigation, has been appointed officer on special duty to investigate the possibilities of expansion of tube-well irrigation in the Punjab, particularly in areas where water-level of the soil is high.

**USE OF TUBE WELLS : IRRIGATION SCHEME FOR  
PUNJAB. 21st August, 1937.**

Same as above.

**OUR ORISSA LETTER : HAVOC WROUGHT BY FLOODS :  
DEMOLITION OF EMBANKMENTS. 22nd August,  
1937.**

Mentions the causes of floods in Orissa and suggests certain remedies. Among the causes, is mentioned the effect of embankments and anicuts. It is stated that these embankments and anicuts stem the flow of water which causes deposition of silt in the river bed and thus causes decrease in the capacity of the river to carry water. It is suggested that (1) the embankments and anicuts should be demolished, (2) a permanent Orissa Flood Relief body be set up, and (3) an inter-provincial board be set up to control and regulate the waters of the Mahanadi, which river is the chief cause of floods.

**TUBE-WELL IRRIGATION. 22nd August, 1937.**

Mentions the appointment of a special officer to investigate possibilities of tube-well irrigation in the Punjab.

**SALT-AFFECTED LAND : AERIAL SURVEY RECOMMENDED. 22nd August, 1937.**

The Punjab Waterlogging Board is understood to have decided that in future aerial surveys should be conducted to ascertain the extent of waterlogging and salt-affected lands.

**HAVELI PROJECT : WORK TO BEGIN NEXT OCTOBER.  
22nd August, 1937.**

**RESEARCH WORK IN IRRIGATION : USE OF MODELS :  
VALUABLE EXPERIMENTS IN INDIA. 24th  
August, 1937.**

Mentions irrigation research by models being done in the various Provinces. Experiments mentioned include design of



weirs on permeable foundations, prevention of scour below barrages, weirs, falls, etc., silt prevention in channels, seepage control, river training, subsoil water level, etc. (This is an official press note issued by the Director, Public Information, Govt. of India, copy of which is also available in this office).

**IRRIGATION RESEARCH : FURTHER EXPERIMENTS  
WITH MODELS OF WORKS : EROSION PROBLEM.**  
25th August, 1937.

Same as above.

**SOIL RESEARCH : EXPERTS TO VISIT KOTRI THIS  
WEEK.** 25th August, 1937.

Rao Bahadur B. Viswanath, Dr. McKenzie-Taylor, and Dr. Basu are to visit the Soil Research Laboratory at Kotri (Sind) to see the nature of the work in the laboratory and to suggest means for improving its activities to benefit cultivation in the Barrage area.

**CURRENT TOPICS : LOSS THROUGH SEEPAGE.** 26th August, 1937.

Mentions the danger of seepage from canals and suggests that, although it may be difficult in the case of big canals, iron or earthenware pipes can be used in case of small canals which will minimize the danger from seepage and water-logging.

**POWER AND PROGRESS.** (Specially written for the "Statesman" by Sir William Stampe, Kt., C.I.E., Chief Engineer, U. P.). 1st September, 1937.

A general article describing the need for development of power, sources of development, and its economic benefits, with particular reference to conditions in U. P.

**IRRIGATION BY TUBE WELL : MODERN METHODS OF  
OBTAINING WATER SUPPLIES : THE VALUE OF  
INDIVIDUAL WELLS.** 1st September, 1937. (By H. A. H.).

A general article describing the advantages of tube-well irrigation over canal irrigation, area that can be served by a tube-well, consideration of the cost of pumping, etc. Refers also to the Ganges Valley Scheme which is the largest tube well scheme in India.

**MAP MAKING WITH A CAMERA : AERIAL PHOTOGRAPHY  
IN INDIA : VAST SAVING IN TIME AND LABOUR.** 1st September, 1937.

A general article describing the advantages of aerial photography in surveying.

**ELECTRICITY IN SOUTHERN INDIA : PROGRESS OF THE  
PYKARA SCHEME. 1st September, 1937. (By Fred  
Barrie).**

The article describes the Pykara Hydro-Electric Scheme in Madras. It gives description of the catchment, runoff, storage facilities, the first stage of the Pykara scheme as well as the Mukurti Dam and Reservoir which is meant to supplement the Pykara supply. Gives the engineering features of the system. Says 'it is the highest head plant in the British Empire, not excluding North and South America'. It is also said to be one of the five highest head plants operating anywhere in the world.

**OUR ORISSA LETTER : A PERMANENT REMEDY FOR  
FLOODS : ORISSA BUDGET. 4th September, 1937.**

At a meeting at which the Orissa Governor presided the need of a permanent remedy for combating the flood evil was stressed and it was suggested that an Embankments and Drainage Division, independent of the Irrigation Department, be instituted to expedite action on the recommendations of the Orissa Flood Committee of 1928.

**BOON TO BENGAL CULTIVATORS : DAMODAR CANAL :  
CROPS SAVED IN YEAR OF DROUGHT. 5th September,  
1937.**

Gives the history of the origin of the idea of constructing this canal and its advantages.

**IRRIGATION : HOW PROBLEMS OF VITAL IMPORTANCE  
ARE DEALT WITH AT LAHORE. (By. Dr. E.  
McKenzie-Taylor). 5th September, 1937.**

An illustrated article describing the work done at the Punjab Irrigation Research Institute at Lahore. The problems investigated include waterlogging, seepage and its treatment with sodium carbonate, the construction and protection of weirs, design of structures on permeable foundations, soil deterioration, and the control of silt in canals. Experiments with models are an interesting feature of the activities of the Institute. A safe design of weirs on permeable foundations has been evolved and the reconditioning of the Merala Weir in the Punjab and of the Damodar Weir in Bengal have been based on these results. Trimmu Weir, the headworks of the Haveli Project, is being designed according to this design.

**EROSION THREAT TO PUNJAB : CANALS SILTING UP.**

7th September, 1937.

The Irrigation Branch, Punjab, has been collecting data on the silt carriage of Punjab rivers and have now come to a definite conclusion that the enormous load of silt—the result of erosion in the foot hill of Jammun and Gujrat—has decreased the carrying capacity of the Upper Jhelum Canal by 40 per cent even with the installation of several silt ejectors at a heavy cost. Dr. R. M. Gorrie gives the causes of this erosion and suggests forest conservation and diminution of potato cultivation and grazing, as the remedies.

**CONTROL OF INDIA'S WATERWAYS : RESEARCH  
SUCCESS : OVERCOMING EFFECTS OF EROSION. 7th  
September, 1937.**

Describes some experiments on river training, storage reservoirs, design of falls, weirs, etc., which have been carried out at the Hydrodynamic Research Station at Khadakvasla.

**FLOODS IN U. P. : PLEA FOR RIVER SURVEY AND  
TRAINING. (By. Ch. Mukhtar Singh). 8th Sep-  
tember, 1937.**

A general article giving causes of floods in U. P., and their prevention. Advocates proper river training and river survey for the purpose.

**TUBE-WELL IRRIGATION IN BUDAON : ADVANTAGES  
THAT PEASANTS CAN DERIVE FROM POWER : TOUR  
OF MINISTER OF COMMUNICATIONS. 10th Sep-  
tember, 1937.**

The Minister for Communications, U. P. presided at a well attended meeting of the Budaon district officials, irrigation officers and zemindars, Sir William Stampe, Chief Engineer, U. P., was also present and explained the hydro-electric development in Budaon, which is one of the western districts of U. P. (A press note by U. P. Government).

**SURVEY OF CROPS AND SOILS IN INDIA : AGENDA FOR  
NEXT MEETING : PUNJAB GOVERNOR TO OPEN  
DELIBERATIONS. 10th September, 1937.**

The second meeting of the Crops and Soils Wing of the Board of Agriculture and Animal Husbandry in India will be held from December 6 to 11 at Lahore. The agenda consists of review of soil survey work in India up to date, the theory and practice of manuring in India, work on the improvement of bullock-drawn implements, plant breeding, water requirements of crops, etc.

**SUBSOIL DRAINAGE IN SIND : AREAS INVESTIGATED.**

10th September, 1937.

Important investigations in connection with subsoil drainage have been carried out in Sind. It has been found that the spring level in Sind is more or less steady and that the subsoil water which had a high salt content before the opening of the Lloyd Barrage Canals has become diluted to some extent since the introduction of perennial irrigation.

**CURRENT TOPICS : HYDRODYNAMIC RESEARCH. 11th**

September, 1937.

Commenting on the press note regarding work being done at the Khadakvasla Research Station, says that "with many calls on the provincial finances it will be quite fit, if research of the kind is conducted by Central Government".

**DETERMINED ATTEMPT TO ACHIEVE UNITY : PUNJAB****PREMIER'S WARNING TO COMMUNALISTS : SPEECH****AT SIMLA : TIRADE AGAINST DR. SATYAPAL. 13th**

September 1937.

In his Speech, the Punjab Premier also referred to the Haveli Project saying that a sum of 68 lakhs has been provided for the Haveli Project during the current year.

**WORLD NEWS BY AIR : ENGLISH GRASS TO CHECK****SILTING : TESTS WITH CUTTINGS. 14th September, 1937.**

Mr. B. L. Suberwal, Dy. Chief Engineer, Bengal Irrigation Department, who had gone to England on holiday is bringing with him rice grass cuttings with the hope that if climatic conditions favour its growth in India, it may prove to be useful for checking silting. Rice grass is a salt water plant which when cultivated in large quantities checks the flow of silt carried in the water and causes the silt to be deposited. Under best conditions, it sometimes raises the level of the land by a foot a year.

**IMPROVEMENTS AT THE METTUR DAM. 17th September,**

1937.

Brief description of some novel works recently constructed at the Mettur Dam. (See Quarterly Bulletin No. 6, pages 10 & 11).

**350 YEAR OLD PLAN : ANCIENT ORIGIN OF METTUR****PROJECT. 20th September, 1937.**

Sir C. P. Ramaswami Ayyar, Dewan of Travancore, disclaims the honour attributed to him of originating the Mettur Dam Project and says that it was thought of by the great Cholas 350 years ago.

**SUBSOIL WATER : IMPORTANT FACTOR IN IRRIGATION.** 21st September, 1937.

Mentions some experiments carried out on soil and irrigation research by the Irrigation Research Division at Poona and Baramati. These experiments comprise the study of typical soil profiles, the physico-chemical changes caused by irrigation and high subsoil water-levels, and the reclamation of soil tilth in damaged lands after drainage. It has been found that irrigation damages some types of soils and benefits others, the depth of the subsoil water being an important factor. Gypsum has been found to be of considerable value for improvement of soil tilth as compared with lime and sulphur. Dhaincha has been found to be most suitable as green manure and nilva as the best fodder crop.

**OCCASIONAL NOTES.** 21st September, 1937.

New uses of cotton have been found for cotton in the U. S. A. They include the reinforcement of asphalt lined irrigation canals and of the banks of dams and reservoirs, the covering of seeding lawns and terraces, etc.

**CHEAP ELECTRICITY FOR EAST U. P. : GRID DISCUSSIONS : COST OF WATER FROM TUBE WELLS.**  
22nd September, 1937.

The U. P. Hydro-Electric Scheme was discussed by U. P. M. L. A's. with the Chief Engineer. Objections, both economical and technical were raised and Sir William Stampe, the Chief Engineer, replied to them all.

**IRRIGATION RESEARCH AT POONA.** 22nd September, 1937.

Same as the cutting "Subsoil Water . . ." dated 21st September.

**FLOOD SITUATION IN ORISSA : MR. ANDREW'S APPEAL FOR RELIEF.** 23rd September, 1937.

Recommends three things immediately required in addition to relief. (1) Malarial survey of Orissa after flood water has subsided. (2) Agricultural inquiry in order to find out the possibility of making a better use of very fertile delta soil outside flood season, (3) Aerial survey by means of aeroplanes not only in Orissa itself but also along the upper courses of Mahanadi and its tributaries. He further says that these will lead to the formation of an inter-Provincial Board working in close co-operation with the Central Board of Irrigation.

U. P. IRRIGATION BUDGET. 23rd September, 1937.

Editor's remarks on the U. P. Hydro-Electric Project advocating the extension of electric development.

CURRENT TOPICS : HIS HUMILITY. 23rd September, 1937.

Refers to Sir C. P. Ramaswami Ayyar's disclaim of the honour attributed to him about originating the idea of the Mettur Dam, and says that although credit is given to the British Govt. for various schemes in India, but if closely examined they will be found to have been planned a long time ago.

IRRIGATION SYSTEM OF INDIA : LEAGUE REPRESENTATIVE TO STUDY. 26th September, 1937.

Mr. Shih-Ta Hsu, a Member and Engineer-in-Chief of the North China River Commission, Tientsin, has been deputed by the League of Nations to visit India and study the great irrigation systems in the country.

BOMBAY COUNCIL : IRRIGATION WORKS. 26th September, 1937.

The Minister for P. W. D., Bombay, in response to a question in the Bombay Assembly, said that the present needs of Gujrat as regards irrigation were being investigated and that the Govt. was also considering participation in the Sabarmati Irrigation Scheme being mooted by the Baroda Darbar.

IRRIGATED LAND : BIG INCREASE RECORDED IN PUNJAB. 26th September, 1937.

Gives figures of increase in irrigation in the Punjab.

RYOT'S GRIEVANCES : PREMIER'S ASSURANCE TO CANE GROWERS. 26th September, 1937.

A deputation of cane growers waited on the Minister for P. W. D., Bombay, urging revision of agreements and reduction of water rates.

THE SARDA CANAL IN U. P. : MAGNITUDE OF ITS UNDERTAKING. 27th September, 1937.

An outline of the Sarda Canal system in U. P. giving extent of irrigation and engineering features. Photographs of certain interesting engineering structures are also given.

LOSS DUE TO SEEPAGE. 28th September, 1937.

Mentions that experiments conducted in U. P. show that treatment with sodium carbonate can reduce seepage losses by about 35 per cent. The cost is said by about Rs. 0-15-0 per hundred square feet.

FLOOD CONTROL IS POSSIBLE: AMERICAN EXPERT'S  
VIEWS. 29th September, 1937.

At a recent conference of those interested in flood control Dr. Bennett, Chief of the Soil Conservation Service, U. S. A., emphasized the necessity for better soil husbandry for prevention of floods. Dr. Lowdermilk explained the run-off characteristics of small and large areas.

M. T. GIBLING,  
*Secretary,*  
*Central Board of Irrigation.*







**GOVERNMENT OF INDIA**  
**CENTRAL BOARD OF IRRIGATION**

**QUARTERLY BULLETIN NO. 8.**

**OCTOBER TO DECEMBER, 1937.**

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**I.I.B.**  
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**SIMLA,**  
**15TH JANUARY, 1938.**

**The Government of India and the Central Board of Irrigation  
are not responsible for the statements made or opinions  
expressed herein.**



# CENTRAL BOARD OF IRRIGATION, 1937.



*Sitting* :—Mr. A. GORDON. (Sind.) Mr. T. A. CURRY. (Bengal.) Mr. G. M. ROSS, C.I.E. (N.W.F. P.) (President). Mr. M. R. RICHARDSON, C.I.E. (United Provinces). Mr. T. A. ANDREW. (Bombay).  
*standing* :—Mr. M. T. GHILING. (Szechuan.) Mr. T. M. LYLE, C.I.E. (United Provinces). Mr. S. H. BOSBY, C.I.E. (Punjab.) Mr. F. M. DOWLEY. (Punjab.) Mr. E. A. FARQUHARSON, M.C. (Punjab.) CAPT. G. E. HALL, M.C. (Bihar.)

Office of the Secretary,  
Central Board of Irrigation,

Simla, H. O.

**QUARTERLY BULLETIN No. 8.**  
**OCTOBER TO DECEMBER 1937.**

**The Board.**

The 8th annual meeting of the Board was held in Delhi from the 30th October to the 4th November 1937. The President of the Board, Mr. G. M. Ross, C. I.E., opened the proceedings. The following are extracts from the President's address :—

“ Eight years ago when the Central Board of Irrigation was constituted we dealt with purely irrigation matters. Since then the scope of the Board has extended and its importance to India increased. We now deal with many allied subjects such as Agriculture, Soil Research, Public Health, Flood Control, Hydro-Electricity, etc., all of which are of vital importance to India as a whole and are subjects on which the advice of Irrigation Engineers is freely sought.

The question now arises as to whether we should change or add to our name, so that the general public may realize that we deal with these subjects. At present they look on us as dealing with Irrigation alone. It is difficult to get a title that is comprehensive and short. I would suggest the designation be changed to the Central Board of Irrigation and Allied Sciences.

Our work is increasing rapidly. When we opened our office in the first instance, our staff consisted of one Secretary *plus* two clerks. It now consists of one Secretary, one Assistant Secretary and 7 clerks, and I anticipate that in the near future further increases will be necessary.

During the year we have held two meetings of our Research Officers instead of one as in former years. The extra meeting was an informal one held in Lahore at the time of the Annual Meeting of the Punjab Engineering Congress. This meeting was an unqualified success and I trust that it will become an annual feature in the future.

The main meeting of our Research Officers which was very well attended was held in Simla in June. Discussions were long and vigorous and there can be no doubt that they were of the greatest benefit to those present and to the whole profession. Although by no

stretch of the imagination could I claim to be a Research Officer, I am intensely interested in the subject and consider it to be one of the most important of the activities of the Central Board of Irrigation. ”

In addition to the President's suggestion, a proposal to re-designate the Board as the “ Central Board of Irrigation, Hydro-Electricity and River Control ” was considered, in view of the fact that some authorities and sections of the public are under the impression that the Board's activities are confined to irrigation only. It was decided not to accept the proposed designation as it was too cumbersome, but to bring to the notice of the authorities and the public, the extent of the Board's activities.

A proposal to hold subsequent meetings of the Board at Provincial Capitals and to invite the Governor of the Province concerned to open the proceedings, was discussed. As it was feared that only a few of the Members would be able to attend the meetings if they were held at considerable distance from their headquarters, and that it was desirable to have as full a gathering as possible, it was decided that the Board meetings should continue to be held in Delhi.

In connection with the problem “ Staunching of Canals ”, the Sodium Carbonate method was discussed at length. Canal beds and side-solpes often contain a proportion of calcium clay, which is previous. If it is treated with sodium carbonate, the calcium clay is converted into a sodium clay which is impervious to water. The clay takes the form of a jelly, and as water alone can change the clay in its new form, and it is impervious to water, the effect is permanent. As this provides a cheap method of staunching canals, investigations have been undertaken in the Punjab, United Provinces and Sind, to ascertain the most efficient and inexpensive method of applying the treatment. Application of the sodium carbonate in a dry form and also as a solution has been tried, but no definite decision as to which is the better method, has yet been reached. Dr. McKenzie-Taylor informed the Board that in his opinion, the wet method is the better as it is not affected by wind and a more even application of the sodium carbonate is obtained.

In a laboratory test at the Punjab Research Institute, a 4” thickness of clay was rendered watertight by the process, even under a head of 13 ft. of water. Field tests in the United Provinces have produced staunching up to 40%, whereas their laboratory experiments have shown as much as 60% staunching. A sodium carbonate lining is considered to be superior to concrete in areas where the sub-soil water level is high, since it is flexible and will withstand the pressure without cracking.

From actuarial analysis in the United Provinces it has been concluded that it is more economical to line the parent channel than to line the “ gul ” (watercourse) system, and that no form of lining except sodium carbonate is financially justifiable.

Difficulty has been experienced in getting the sodium carbonate applied to the canals in the time at disposal in an ordinary closure, and it has not been possible so far to measure the extent of the benefit from the treatment since the inaccuracies involved in measuring discharges with current meters are

likely to amount to the reduction in losses effected by the treatment. The benefit to a channel is being gauged from the quantity of water available at its tail after treatment, compared with that available beforehand. The Board passed the following resolution in connection with the sodium carbonate method of lining :—

*Resolution.*—This Board is of the opinion that the further experiments carried out with sodium carbonate have indicated that the treatment is cheap and effective in rendering canal beds less pervious. The Board recommends that further experiments on as large a scale as possible be carried out, and the results reported to the Board.

Mr. Edgecombe informed the Board that investigations were in hand in the United Provinces to ascertain whether molasses is an effective medium for waterproofing channels. Laboratory experiments have proved very satisfactory and they are to be extended to the field. If molasses is found to be suitable for this purpose it will provide a good use for a by-product of sugar cane factories which at present has very little value.

To measure absorption losses in the United Provinces canals they measure discharges over calibrated weirs with automatic gauges. A period of about a week, over which the charts show steady discharges, is selected, and the volumes of water passing the upper and lower sites are calculated ; the difference being the losses. When calibrating the weirs, they take as many discharges as possible in order to eliminate errors. If there is an error of 3% in one observation, there will be an error of 1% only from the results of 9 similar observations. When calibrating the weirs they measure the discharges with rods.

Arising out of the question “ Means to secure the Equitable Distribution of Irrigation Water ”, is the problem of the water requirements of crops, and during the discussions, Mr. Montagu informed the Board that investigations undertaken by him in connection with tube wells, indicated that for irrigation from wells, cultivators used about half the quantity of water that is used from canals, and at double the cost. Closely allied to the water requirements of crops is the question of the manurial value of silt. It has been estimated that in some areas in Bengal, a single watering from the canals is worth eight annas per acre from the manurial value of the silt alone.

The Board passed the following resolution :—

*Resolution.*—This Board is of the opinion that the question of water requirements of crops and manurial value of silt is of great importance, and should be one of the first investigations undertaken at a Central Research Station for Irrigation, if and when established.

During the discussion on the question “ The fair incidence of the cost of irrigation water on different classes of crops ”, Mr. Gordon suggested that some system of assessment might be introduced which would encourage good cultivation. For example, it is highly beneficial to grow “ guar ” along with cotton, and cultivators might be encouraged to adopt the practice by lowering the assessment for the mixed crop, or by raising the assessment for cotton alone.



The following resolution in connection with the design of canal falls was passed by the Board :—

*Resolution.*—It is resolved that Mr. Inglis's Report on the Design of Canal Falls should be examined by the Research Committee at its next meeting with a view to the Report being issued as a Board publication.

The Board accepts the opinion of the Research Committee that comprehensive research into the subject of the design of canal falls is desirable, and that until such research has placed the principles of design beyond dispute, it is inadvisable to record any recommendation in favour of any type of design for general application. The Board also accepts the Research Committee's opinion that wide publicity should be given to the results obtained by officers engaged in this line of enquiry.

The Board approved of the following new subjects being taken up for investigation by the Research Committee next year :—

- (1) The Collection of Hydraulic Data of torrents in Boulder Rivers and Streams.
- (2) Silt Excluders and Ejectors.
- (3) The Preparation of a Guide to the collection of Statistics.

The following resolution in connection with the design of works on permeable foundations, was passed :—

*Resolution.* This Board desires to place on record its appreciation of the very valuable work done by Rai Bahadur Ajudhia Nath Khosla, Dr. N. K. Bose and Dr. E. McKenzie-Taylor, the authors of Board Publication No. 12 entitled "Design of Weirs on Permeable Foundations", and to convey its thanks to those officers, and to the Punjab Irrigation Department for the opportunity of publishing the results of the investigations in the form of a Board Publication.

The following resolution regarding the design of channels in alluvium was passed :—

*Resolution.*—The Central Board of Irrigation wishes to draw the attention of the Government of the United Provinces to the difficulty engineers in India are faced with when applying the results of Mr. Gerald Lacey's work to the practical design of channels in alluvium. Mr. Lacey's work is of incalculable potential value to them, but is not easily accessible as it is scattered in several publications. Because of this difficulty, India as a whole is not profiting from this officer's work to the extent it should do and the Government of the United Provinces would be doing a great service to the engineering profession as a whole and, in view of the importance of irrigation, to India and especially to the Indian cultivator, if they could see their way to place this officer on special duty for such a period as may be necessary to

allow him to write up for publication by the Board a complete note on his researches.

Such a publication would also have the great advantage of focussing attention to divergences of views on details of application known to exist among irrigation engineers. It would stimulate further research in this most vital subject.

After discussing the problem of flood control the Board passed the following resolution :—

*Resolution.*—The Central Board of Irrigation desires to draw attention to the Proceedings of the British Empire Forestry Conference, South Africa, 1935, with particular reference to the possible dangerous effects of deforestation on irrigation in India.

These effects are :—

- (a) the increase of intensity of floods,
- (b) the decrease of the dry weather flow in rivers.

The former would mean greater capital expenditure and more expensive maintenance on canal headworks, thus possibly making otherwise productive projects unproductive, and difficult to finance. The possibility of damage to existing works should also not be overlooked. In addition, and what is most important of all, there is the greater tendency to flooding of vast tracts of country.

A decrease in the dry weather flow of rivers would have most serious effect on those cultivators who rely on canal supplies to mature their crops. Even those who rely on irrigation from wells might be affected by lowering of the sub-soil water table.

These detrimental effects have already been noticed in some of the smaller river basins. Although there is no absolute proof of the larger rivers yet having been affected by deforestation, the Board is of the opinion that India cannot afford to neglect the experience of other countries.

The problem is not usually a Provincial one, as most of the basins of larger rivers lie in more than one Province or State, and deforestation in one administration may produce most serious results in another.

The Forest Department has from time to time drawn attention to the dangerous effects of deforestation on rivers, and the Board desires to endorse those warnings.

The Board also decided to collect information regarding the existing river and rain gauging stations, and data available, with a view to recommending the establishment of further such stations if found necessary, and the co-ordination of the collection of data.

Sir William Stampe addressed the Board on “ Inter-Provincial Power Development in India ”, and a general discussion on hydro-electric projects followed. The Board passed the following resolution :—

*Resolution.*—The Board has observed that in certain provinces where hydro-electric undertakings are in operation and commercial

accounts are kept, the sums which are annually debited against the maintenance of the scheme on account of depreciation are not funded but are merely kept in floating deposit in the provincial budget surplus. In view of the fact that depreciation funds are supposed to be maintained for the replacement of particular items of machinery after a period of years and annual debits are based on the period of years thus assumed, the Board feels that any sums debited against the revenue accounts of such projects should be credited to a separate depreciation fund which should be kept either with the Controller of Currency or invested in definite securities. Any sum that may accrue in the form of interest on such securities should be credited to the general revenues of the scheme and shown as revenue in the pro-forma accounts.

Should any disaster happen to the scheme as a whole or to any of the power stations as a result of floods or other natural cause, the depreciation fund should be available as a separate entity from which to finance the replacement of machinery thus damaged. The Board trusts therefore that provinces will adopt the principle of funded depreciation accounts for these reasons.

During the discussion on the " Questionnaire on conditions predisposing to harmful soil saturation which may ultimately result in waterlogging ", the important fundamental problem of the extent to which rain, seepage from canals, and water applied to the land, were responsible for the rise of the sub-soil water table, evoked considerable discussion. Investigations are in hand in the Punjab, United Provinces and Sind, which may lead to the solution of this problem.

Members of the Board and other officers attending the meeting visited the Imperial Agricultural Research Station at New Delhi.

On the 2nd November the Board attended the opening ceremony of the Chitaura Power Station, which was performed by His Excellency the Governor of the United Provinces. Other works connected with the Ganges Hydro-Electric and Tube-Well Schemes were also visited the same day.

The question of establishing a Central Research Station for Irrigation was discussed at length by the Board, particularly in relation to the following recommendation contained on page 220 of Sir John Russell's report on " The Work of the Imperial Council of Agricultural Research in applying Science to Crop Production in India, 1937 " :—

*" Improvement of the water supply for crops.—*This is one of the most important of all agricultural problems in India and perhaps the most difficult. It is too big to form part of a programme, and I recommend the establishment of a Central Irrigation Station for all-India where the agricultural problems can be worked out. At this station the relations of soils, water, and growing crops would be studied, also the interaction between salt water and soil, the reclamation of salted and alkaline land, the movements of subsoil water, and the agricultural effects of various sequences of crops.

Provision should also be made for more complete co-ordination of the investigations on dry farming, and for linking it up with the work of the proposed Irrigation Research Station ”.

The Board passed the following resolution by a majority of six votes to four :—

*Resolution.*—This Board is of the opinion that a Central Irrigation Research Station equipped to investigate irrigation problems and also all agricultural problems associated with irrigation, as recommended by Sir John Russell in paragraph 3, page 220 of his report, is essential.

2. The Station should be financed by the Government of India for the following reasons :—

- (i) Irrigation is of all-India importance and large revenues accrue therefrom to the Central Government.
- (ii) The Government of India at present make no contribution towards Irrigation research in India whereas they support to the extent of many lakhs of rupees Forestry, Agriculture, Veterinary research and Industries. To mention only two examples, the Forest Research Institute at Dehra Dun, and the Agricultural Research Institute at Pusa, the cost in 1933-34 amounted to Rs. 6.05 lakhs and Rs. 7.63 lakhs respectively.
- (iii) The Provinces finance their own Irrigation Research entirely and receive from the Central Government no contribution, such as is provided by them for research in other subjects.
- (iv) Except for a small contribution from the Central Government in the form of office accommodation, printing, and stationery, and expenses in connection with the International Commission on Large Dams, the Provinces entirely maintain the Central Board of Irrigation, whereas the Imperial Council of Agricultural Research and other similar bodies are financed by the Government of India, though the subjects dealt with are definitely provincial subjects, as is irrigation.
- (v) Continuity of research, and therefore stability of income, are essential, and they should not be dependent on contributions and subscriptions from the Provinces. To ensure such continuity and stability to a central research institute, adequate permanent maintenance by the Government of India is essential. The resources dependent upon contributions from the Provinces, States and other bodies are liable to fluctuate, and under provincial autonomy, impossible to assess.
- (vi) The Railways, and hence the Government of India would derive considerable benefit from a research station dealing with river training and control.

3. The Central Research Station should be situated as near Delhi as possible, and Chajunagar on the Agra Canal is suggested as a possible site.
4. In order to secure continuity of the work now in hand the Government of India should continue to finance the Hydrodynamic Research Station at Khadakvasla for hydrodynamic work, until such time as the new Station is ready.

The following new subjects were accepted for investigation during the ensuing year :—

The Fertility of Silt.

The Effect of Deforestation on Irrigation Projects.

The following office-bearers were elected for the ensuing year :—

Mr. M. R. Richardson, C.I.E., Chief Engineer, U. P., *President*.

Mr. A. Gordon, C.I.E., Chief Engineer, Sind, *Vice-President*.

Mr. J. D. H. Bedford, Chief Engineer, Punjab, *Third Member of the Executive Committee*.

The following changes in the Membership of the Board have taken place during the quarter :—

Sir William Stampe, Kt., C.I.E., Chief Engineer, United Provinces, retired from 1st November 1937. As the post which he held has been abolished, there will now be only two U. P. Members instead of three.

Mr. C. C. Mackintosh, Chief Engineer, Burma, returned from leave at the beginning of November and took over from Mr. A. A. H. Ricketts.

Mr. H. A. Hyde, C.I.E., M.C., Chief Engineer, C. P., proceeded on leave preparatory to retirement with effect from 16th November 1937 and Mr. P. V. Chance has succeeded him.

#### **Research Committee.**

Dr. N. K. Bose, Mathematical Officer, Punjab Irrigation Research Institute, Lahore, is officiating as Director of the Institute during the absence on leave of Dr. E. McKenzie-Taylor.

#### **Board Publications.**

1. Revised edition of the "Glossary" (Publication No. 5) is still under preparation as replies from some officers are still awaited.

2. Mr. C. C. Inglis has written a note entitled "Instructions for Designing Standard Standing Wave Flumes", and if it is accepted by the Board it will be issued as a Board Publication.

3. Board Publication No. 12 entitled "Design of Weirs on Permeable Foundations" by Rai Bahadur A. N. Khosla, Dr. N. K. Bose and Dr. E. McKenzie-Taylor is now undergoing final printing, and copies will be distributed to Provinces early in the new year. In addition to providing a complete guide to the design of works on permeable foundations, this publication contains very useful information regarding the maintenance of those works, and the design of retaining walls, etc.

4. The questionnaires on "Conditions Predisposing to Harmful Soil Stauration which may Ultimately Result in Waterlogging" and "Land Reclamation" are to be printed up in the form of Notes, and distributed to Provinces.

5. At the last annual meeting the Board decided not to accept Mr. P. Claxton's Note on "Silt Load on the Behaviour of Rivers" as a Board Publication.

6. The Board accepted the recommendation of the Research Committee that the U. P. Government should be asked to place Mr. Gerald Lacey on special duty to write a publication on the Design of Channels in Alluvium.

7. The question of publishing Mr. C. C. Inglis's report on his experiments with the design of canal falls as a Board Publication was referred to the Research Committee.

### **Works Section.**

#### **UNITED PROVINCES.**

##### *Chitaura Power House.*

This Power House is a duplication of the Salawa Power House (notes about which have been published in Bulletin No. 5), i. e., it is designed to give a continuous output of 3,000 k. w. by means of two turbo-alternators operating on a head of 15 ft. It is also sited on a by-pass from the Ganges Canal.

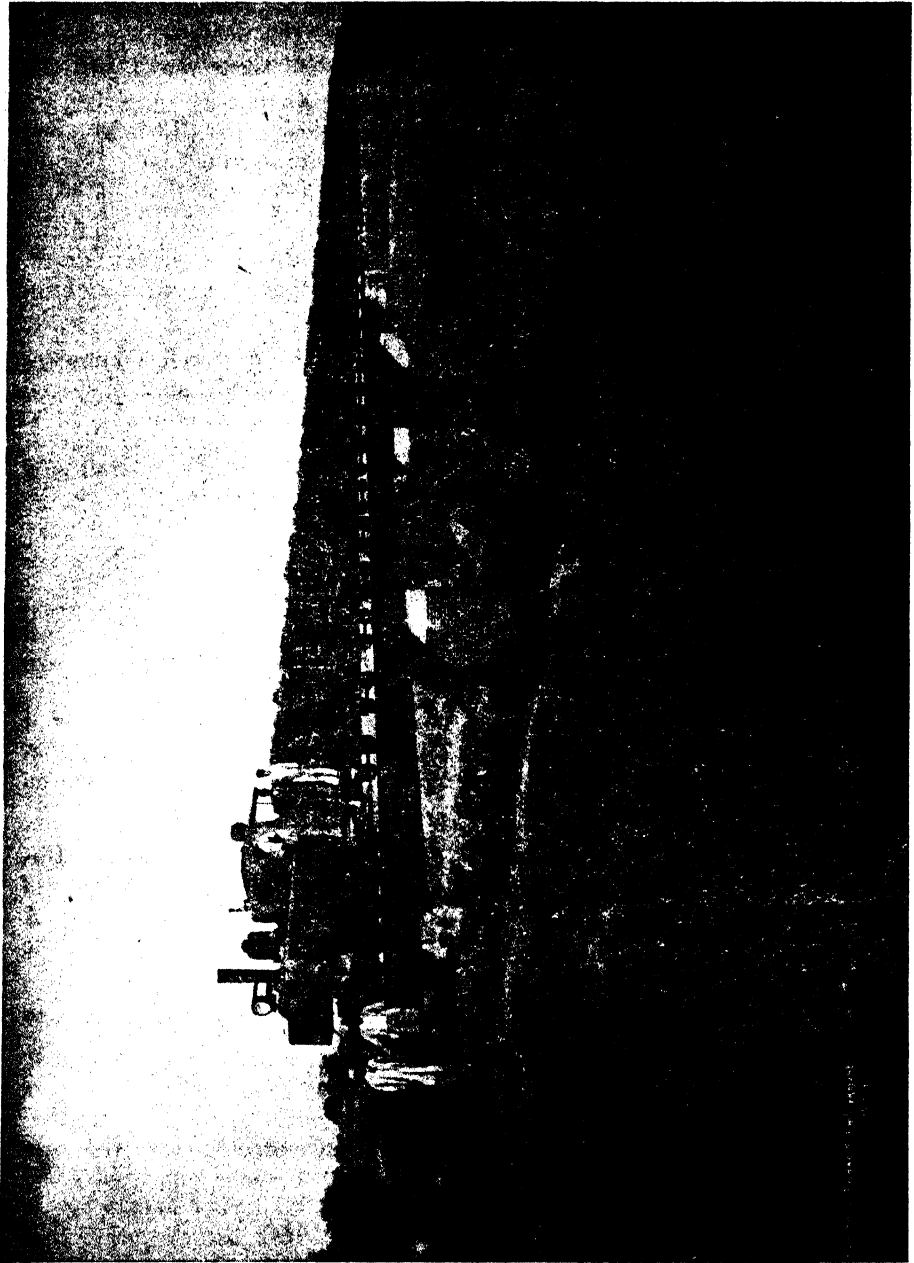
The total cost of the Power Station is approximately Rs. 15 lakhs. Unlike Salawa, where the foundations were particularly bad and consisted of running sands, Chitaura is founded on a reinforced concrete open Slab. A few masonry wells only were sunk at the points where the main loads of the machines were concentrated.

Work was commenced in September 1935 and the Station was put into commission in April 1937.

##### *Nirgajni Power House.*

This Power House of 4,000 k. w. capacity is estimated to cost, with subsidiary works, Rs. 7,97,508 (for civil works only). A water supply of 4,000 cusecs is available with a head of 15 ft. The general layout and design is similar to the Salawa and Chitaura Power Houses, with the exception that Nirgajni Power House is founded on Franki piles (as against masonry wells in the other power houses). These piles have proved eminently suitable as foundations.

Very little trouble in laying the foundations was experienced due to the total excavation being in good clay which goes down some 6' below spring level.



Franki pile driving was commenced early in November 1936. The power house, ready for machinery erection, was handed over to the North Hydrel

Division on the 7th April 1937. The Station is expected to be finished in all respects in February 1938.

### *Daurala Sugercane Tramway project.*

This Tramway Project was conceived early in 1934, with the object of providing transportation facilities for sugarcane grown in the irrigated tracts of the Anupshahr Branch of the Ganges Canal. Lack of communications in the past had prevented the sale of sugarcane to the factories.

There are six factories situated on the North Western Railway between Begamabad and Muzaffargarh to which supplies can be made from the Tramway.

The Tramway alignment is from Daurala, east to Dhakauli, a distance of  $14\frac{1}{2}$  miles, thence one branch running north for 5 miles to Kaul, and a second branch running south for  $8\frac{1}{2}$  miles to Parichatgarh.

A gauge of 2 ft. wide adopted. For the track  $41\frac{1}{2}$  lb flat-bottomed steel rails spiked to sal wood sleepers were used. Some 35 lb and 30 lb rails were also used. The ruling gradient is 1 in 330.

Bridges are of steel girders with masonry foundations, the sleepers being seated directly on the girders. The Kali Nadi Bridge (shown in the photograph on the opposite page) provides 3 spans of 30' and two end spans of 16'; abutments have open foundations but piers are founded on wells sunk to 28' below the bed level. Main culverts are of reinforced concrete. Smaller ones are of Hume pipes with masonry parapets.

The present stock of locomotives consists of 5 Baldwin locomotives of 50 H. P. and one Oriensteen & Koppal of 20 H. P. The rolling stock consists of 80 five ton capacity open four-wheeled trucks and 70 three ton capacity open trucks.

The total cost of the Tramway is approximately Rs.  $5\frac{1}{2}$  lakhs.

### *"Usar" Reclamation on the Sarda Canal.*

In conjunction with the Agricultural Department, plots of light usar are being reclaimed in the lower portions of the Sarda Canal. To date, approximately 400 acres have been taken up. The process consists of sowing sun hemp with canal water in May, and afterwards ploughing in and sowing a salt resisting rice. Water is given free to land owners for two years to encourage them to break up their light usar land, and the results to date appear promising.

### **Information Bureau and Library.**

The following are some of the enquiries dealt with during the quarter :—

Rainfall and Run-off.

Silting of Reservoirs.

Navigability of Indian Rivers.

Sub-soil Drainage.

Siltometers.



**Miscellaneous.**

1. The Hydrodynamic Research Station at Khadakvasla (near Poona) is to be continued during the next financial year, provided the Secretary of State will agree to an extension for Mr. Inglis, the Director, who is due to retire in February 1938. All new experiments carried out for Provinces and other authorities will have to be paid for, and no work will be undertaken which cannot be completed during the year 1938-39.

2. A questionnaire on "Drainage systems in irrigated areas" has been prepared, and copies will shortly be sent to Provinces with a request for information regarding existing drainage systems.

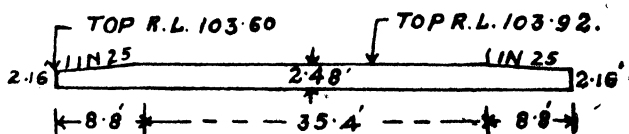
3. Sir Bernard Darley, Kt., C. I. E., formerly Chief Engineer in the United Provinces, and Bahawalpur State, has taken over the duties of honorary representative of the Central Board of Irrigation on the International Commission of Large Dams. The Central Board of Irrigation constitutes the National Committee for British India.

4. At the last Board meeting the question of selecting an officer to succeed the present Secretary of the Central Board of Irrigation in 1939 was referred to the Executive Committee of the Board, and a selection will be made early in 1938 to enable the selected officer to take long leave before taking over charge for a period of four years.

5. The design of a Fall of 5.2 ft. for 1630 cusecs, which was supplied by Mr. C. C. Inglis, was reproduced in the last Bulletin (facing page 15). Mr. Inglis has now improved the design of the baffle as follows:—

### FRONT ELEVATION OF THE BAFFLE.

SCALE: 20' = 1 INCH.



Mr. A. M. R. Montagu, Executive Engineer, Punjab, has also designed a fall for the same conditions and it is shown in the sketch on the opposite page.

6. Preliminary experiments are to be carried out in Bengal on the construction of asphalt revetments for river bank protection, similar to those in use in the U. S. A. (For further particulars see under "Other Publications" in the Literature Section of this Bulletin).

7. The following are some notes in connection with works in progress in the Punjab:—

(a) *Haveli Project*.—Work on the Trimmu Headworks and the Main canal is in full swing.



# HYDRAULIC DESIGN OF A FALL

supplied by

Mr. A. M. R. Montagu.

Scale  $\frac{1}{15}$

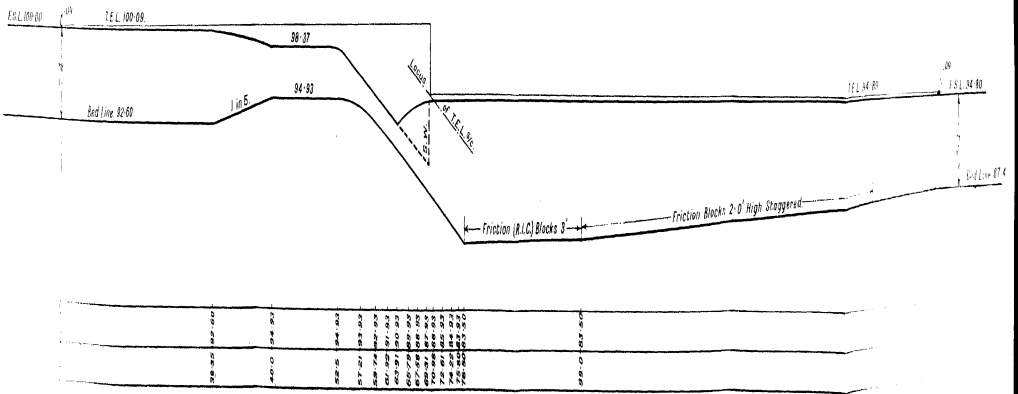
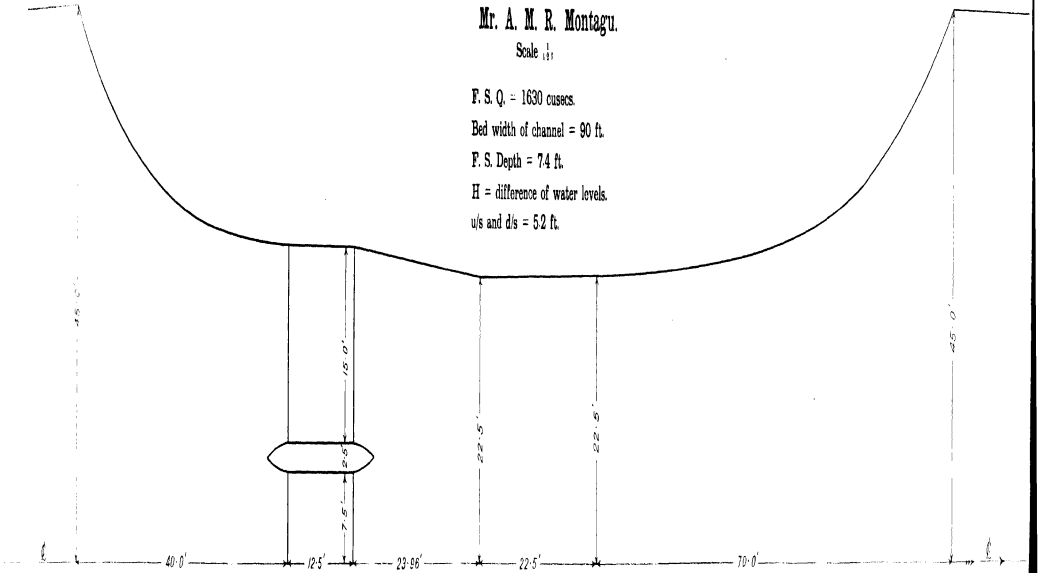
F. S. Q. = 1630 cusecs.

Bed width of channel = 90 ft.

F. S. Depth = 7.4 ft.

H = difference of water levels.

u/s and d/s = 52 ft.





Trimmu Headworks is being designed in the light of the latest hydraulic researches. Its design is in advance of anything that has been done in the Punjab so far. The entire section of the Weir and the undersluices is a reinforced concrete slab of 1 : 2 : 4 concrete designed to withstand the upward hydrostatic pressure due to a head of 29 feet in the undersluices and 25 feet in the case of the Weir. Between the piers the reinforced concrete slab is designed as a raft foundation on Baker's Soil Line theory. Thus the objections of layers of concrete separating from each other, so troublesome in old weirs, have been eliminated. A factor of safety of 5 has been allowed in the downstream exit gradient.

Another important point in the Weir design is that all the important structures, such as gates and bridges for the superstructure of gates and arterial road have been enclosed by two lines of sheet piles, placed at the upstream and downstream toes of the glacis. These sheet piles increase the bearing value of the soil enclosed by them and serve as important lines of second defence, in case the downstream floor is damaged in any bay.

A very up-to-date silt excluder is being combined with the undersluices to exclude all coarse silt from entering the Canal.

Every detail of the design has been tested in the Hydraulic experimental stations at Lahore and Malikpur.

The entire Main Line in a length of about 45 miles is being lined with two layers of reinforced brick tiles  $12'' \times 6'' \times 2''$  enclosing a  $3/8''$  layer of 1 : 3 cement mortar between them. The section of the canal is 80 feet bed width and 12 feet depth. As the co-efficient of rugosity is less in a lined channel, as compared to an unlined one, a smaller section is sufficient to pass the same discharge with the same slope. The result is that the lined channel of the main line will cost only 10 lakhs of rupees more than the project provision of an unlined channel.

All channels on the Haveli system are being designed with facey's  $f = 0.8$ . In a few cutting reaches, where there is appreciable slope in the country, the value of Lacey's  $f$  has been taken up to a maximum of 0.9. The silt excluder at the head will exclude all silt coarser than  $f = 0.8$ .

Special concession rates have been obtained for cement and reinforcement steel by careful negotiation.

(b) *Islam Weir*.—The work on driving a pile line downstream of Islam Weir is progressing satisfactorily.

(c) *Western Jumna Canal*.—The undersluices of the Western Jumna Canal at the Tajewala Headworks consist of 20 feet bays with springing of acrches at R. L. 1070.5 against the Highest Flood Level of 1070. The undersluices are now being remodelled at a cost of Rs. 1,75,000 to provide a clear waterway up to the highest flood level, and proper gates are being put in. This will increase the capacity of the undersluices considerably and reduce the chances of the bays being fouled by trees in floods.

This is the first part of the scheme sanctioned for Rs. 5,74,000 in order to enable the Weir and undersluices to pass a maximum flood of 5 lacs of cusecs instead of the existing designed discharge of  $3\frac{1}{2}$  lacs.

(d) *Kashmir Canal*.—The Kashmir Canal of the Kashmir State is fed by heading up water by a boulder masonry bar across the Ravi river in the vicinity of Madhopur, called the Dhanna Weir, the central part of which was washed away in 1935 due to erosion downstream of the Weir and after this, retrogression of the bed of the river proceeded so rapidly that the command of the Kashmir Canal was seriously at stake. As no other site was found suitable for a new bar, the old Dhanna Weir is being repaired at a cost of about Rs 1,20,000 during this winter.

8. In 1936-37, as a result of concerted action of the Director of Agriculture, U. P., and Mr. M. R. Richardson, Chief Engineer, Irrigation Branch, U. P., the Government of the United Provinces sanctioned the opening of two demonstration centres on the Mat Branch of the Ganges Canal. At these centres the most suitable crop rotations for the water normally available to zemindars will be demonstrated.

9. The following are some of the investigations recently carried out or are still in progress in the United Provinces.

(1) Two investigations by models have recently been undertaken.

(i) In the case of the Bahadurabad Power House, Upper Ganges Canal, a model was constructed to determine (a) what combination of discharges through various bays produces the maximum scour, and (b) which combinations are permissible if scour is to be minimized.

The model was constructed to a scale of 1/25 and sand from the Gomti river was used. Three series of experiments were conducted with discharges of 0.96, 1.60 and 2.24 cusecs in the model, representing 3000, 5000 and 7000 cusecs in the prototype. The results arrived at were that the minimum scour in each series of experiments took place when all the bays were running with equal discharges, while the worst scour occurred in the case of 3000 cusecs discharge when the third bay was running with 1500 cusecs, the 4th with 500 and the fifth with 1000 cusecs, all the other bays being closed. Conditions of worst scour in case of 5000 and 7000 cusecs discharge were also investigated and determined.

A few more experiments were carried out to see if the extension of piers affects the scour in any way. It was found that if all the seven piers are extended by 12' in the model, representing 25' in the prototype, the worst scour occurring in each series of experiment, was reduced by about 40%.

(ii) In the case of the Flumed Fall at M. 18-1-495 Mat Branch, a model was constructed to determine a device for the prevention of the severe scour which occurred below the fall.

The model was constructed in brickwork to a scale of 1/14. A number of experiments totalling sixty seven were carried out and different devices in the form of Montagu friction blocks, deflectors, rectangular and trapezoidal baffles were tried at different positions in the floor. A 21" high baffle wall placed 43 ft. downstream of the crest gave the best results, reducing the scour by 85%. A sketch of this baffle design is available in the Board's office.

(2) The design of the model of the Absara syphon, Rohilkhand Canals Division is in hand, and experiments for designing a device to reduce the scour occurring below this work will shortly be taken in hand.

(3) In order to estimate the life of the Khurwai Reservoir the ratio of the mean annual runoff to the capacity of the reservoir with the rate of silting was plotted in the case of 14 dams in India and the United States. The results obtained are that when the above ratio exceeds 20 the rate of silting decreases with the decrease of the ratio in a regular manner, but when the ratio is below 5 there is no connection with this ratio and the rate of silting. A graph showing the plotting of these ratios is available in the Board's office.

(4) Observations of the water profile in connection with the calibration of the Karon Nadi flume on Hathras Branch have been analysed to ascertain the Etcheverry constants for the inlet and outlet transitions of a flumed section. They work out to 1.30 and 0.86 against 1.10 and 0.75 recorded by Prof. Etcheverry. Instructions for the preparation of standard designs for flumed sections will be issued later.

The following officers of the Irrigation Departments of the various Provinces received the honours noted against their names on New Year's Day :—

Alexander Gordon, Esqr., I. S. E., Chief Engineer and Secretary to the Government in the P. W. D., Sind .. ..	C. I. E.
Alfred Vipan, Esqr., I. S. E., Chief Engineer and Secretary to Government of Orissa, Public Works Department ..	C. I. E.
Diwan Bahadur Gopaldas Hassanand Keswani, I. S. E., Executive Engineer, Sind .. ..	M. B. E.
Babu Ramani Mohan Sinha, Executive Engineer, Bankura Division, Irrigation Branch, Communications and Works Department, Bengal Presidency .. ..	Rai Bahadur.
Mr. Mohammad Fakhur-ud-Din, Executive Engineer, P. W. D., Irrigation Branch, Punjab .. ..	Khan Bahadur
Mr. D. V. Joglekar, Bombay Service of Engineers, Asstt. Engineer (at present officiating Executive Engineer, Central Irrigation and Hydrodynamic Research Station, Poona), Bombay Presidency .. ..	Rao Sahib.
M. R. Ry. Kesava Rao Tombat, Avargal, officiating Executive Engineer, Madras Presidency .. ..	Rao Sahib.
Babu Subodh Chandra Ghosh, Overseer, Subordinate Engineering Service, P. W. D., Bihar .. ..	Rai Sahib.

#### LITERATURE.

The following literature was received during the quarter.

*Readers are reminded that they are at liberty to borrow any of the literature in the Board's library, in accordance with the rules published in Bulletin No. 3 and to submit enquiries on any matter dealing with irrigation and allied subjects.*





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## PERIODICALS.

## CIVIL ENGINEERING AND PUBLIC WORKS REVIEW.

Vol. XXXII.

No. 375—September 1937.

## FOREIGN NOTES.

## A MULTIPLE ARCH DAM.

A multiple arch dam at Beni-Bahdel, Algeria, built in reinforced concrete, in which the arches have an unusually large span is described in *Bull. Tech. Suisse Rom.* 63, 141. The total length of the dam is 1,056 ft., the central 726 ft. consisting of eleven arches while the wings are of gravity type. The counterforts are 66 ft. apart and are triangular. The arches are cylindrical with a diameter of  $56\frac{3}{4}$  ft. The thickness of the arches varies from  $4\frac{1}{4}$  ft. at the bottom to 2.3 ft. at the top and they spring from strongly reinforced concrete skewbacks resting on the inclined faces of the counterforts. Geological features of the site are described and a few other details of the work are given.

## THE STORSTROM BRIDGE COMPLETED.

Engelund.

The main features of the design and construction of this bridge in Denmark are described. The total length of the bridge is about 2 miles and it consists of three navigation spans near the centre and forty-seven smaller spans. The navigation spans are of plate girder reinforced by polygonal arches. The smaller spans are all of plate girder construction.

The piers consist of hollow reinforced concrete shafts resting on a solid mass of concrete. The average depth of pier foundations is 23 ft. The contractors developed a special method of pier construction in open cofferdams, utilizing special movable steel cofferdams instead of the usual sheet piling cofferdams. This equipment and its operation are described in detail.

## STAINED BRICKWORK : ITS CAUSES AND REMEDY.

In Technical Bulletin No. 3 entitled "Efflorescence and Staining on Brickwork" issued by the Clay Products Technical Bureau of Great Britain, the exact causes of and the possible remedy for the white staining or efflorescence which occurs on brickwork, are fully outlined.

The salts most frequently causing this disfigurement are the sulphates of magnesium, sodium and calcium. The sources of these may be either external or internal. The external source is the soil which contains a greater or lesser amount of the salts dissolved in the soil moisture. In the absence of a damp-proof course the soil moisture is drawn up by capillary action to the surface of the brickwork and on evaporation the salts are left on the surface as a white incrustation. The internal sources are the mortar or brick. Rich and dense mortars containing a high

proportion of Portland cement or hydraulic lime or salt polluted aggregates are a frequent source. Precautions to be taken to eliminate efflorescence include

- (1) Use of hard fired bricks in which there is no possibility of formation of the harmful salts.
- (2) Introduction of damp-proof courses in all walls.
- (3) Use of a correct mortar.

#### **THE FERNILEE RESERVOIR.**

The new waterworks for Stockport Corporation includes a reservoir in the valley of the river Goyt which is a tributary of the Mersey. The dam forming the reservoir is of the earthen fill type with a puddle core. A mass concrete cut-off wall is continued into the rock below the puddle core. It is 650 ft. in length, 132 ft. high and 680 ft. thick at the base. The puddle core is 30 ft. thick at the base and 6 ft. at the top. The concrete cut-off wall is 6 ft. thick carried into the rock to a depth varying from 50 ft. to 232 ft. It is built of 5 : 1 mass concrete, and is 950 ft. long. To prevent infiltration below and beyond the cut-off, extensive grouting has been employed, the total number of holes being 61 with a length of 12,000 ft. The dam has a roadway on the top 19 ft. 6 inches wide.

#### **IMPOUNDING THE RIVER DERWENT : GOOD PROGRESS ON THE LADYBOWER RESERVOIR.**

The Derwent Valley Water Board is constructing a reservoir known as the Ladybower Reservoir for the water supply of Nottingham and Sheffield. The dam forming the reservoir is an earthfill structure 1,250 ft. long and 141 ft. high with a puddle core and concrete cut-off wall in the rock below. The upstream slope has a batter of 1 : 3 and is stone pitched. The downstream face has a slope varying from 1 : 1½ to 1 : 2½. The free board is 10 ft. in view of considerable wave action which might be expected. Two bellmouth overflow weirs are provided to dispose of flood water. A number of model experiments were carried out at Manchester University to arrive at the final design of these overflow weirs. In the design finally adopted the interior of the bellmouth is stepped instead of smooth, and radial cut waters are provided on the lip of the bellmouth to prevent vortex formation.

#### **BUILDING SCIENCE ABSTRACTS.**

##### **EFFECT OF TEMPERATURE ON THE STRESS-DEFORMATION OF CONCRETE.**

In a study of concrete creep, investigation has been made of the effect of temperatures ranging from 26°F. to 123°F. on the elastic and plastic deformation of Portland Cement Concrete specimens subjected to a sustained compressive stress of about 20 per cent. of their ultimate strength. These investigations and the conclusions arrived at are described.

## VACUUM CONCRETE.

A description of the vacuum concrete process in which the water content is reduced by about 40 per cent. under a pressure of about  $\frac{1}{3}$  atmospheric pressure is given. This process obviates the necessity for heavy shuttering, and permits early removal of shuttering. Tests on vacuum treated concrete show that it is 30 to 100 per cent. stronger than ordinary concrete at the same age and that a 25 per cent. economy in cement is possible.

No. 376—October 1937.

## FOREIGN NOTES.

### SLAB BRIDGES.

Where headroom is limited, the simple slab type of bridge deck has many advantages for short and moderate spans. In *Beton und Eisen* 36, 209, W. Preisser describes the construction of several of these bridges with spans up to 104 ft. Where there is only a single opening the two-hinged portal form of construction is usually adopted, the abutment walls being made monolithic with the deck and hinged at the foundations. The bridge over the Lippe at Hanover has a span of 104 ft. The deck slab is 23.2 ft. wide, 3.45 ft. deep at the centre and increasing to 6.1 ft. at the abutments. The abutments are 6.1 ft. thick and the hinges are 20.5 ft. below road level, sunk into depressions in the foundation blocks.

### BRIDGE BUILDING IN INDIA.

This article describes the Patalganga Bridge in the Bombay Presidency over a tidal creek where the water level ranges from 87.9 ft. at low water to 97.1 at high tide. The bridge consists of three reinforced concrete bow-string spans in the main stream with three continuous beam approach spans at either end. The bow-string spans are 100 ft. each and the approach spans are 48 ft. each giving a total length between abutments of 584 ft. 6 in. Foundations in open excavation were adopted for the abutment and two shore piers at the south end. The foundations of the four piers supporting the bow-string spans were constructed by sinking thin reinforced concrete cylinders. Two cylinders 11 ft. 10 in. outside diameter were provided under each pier and they were cast on artificial islands constructed in the stream at the pier sites. They were sunk by ordinary hand excavation in the open, and when solid rock was reached they were filled with 1:2:4 plum cement concrete. Reinforced concrete caps were provided over the cylinders to carry the piers. The foundations under the shore piers and abutment at the north end consist of masonry wells, two on each foundation built of rubble masonry in 1:4 cement mortar and plastered on the outside with the same mortar. A feature of the construction of these wells is the sealing of the bottom. As the concrete

had to be placed in water, it was carried out by colloidal grouting. This consists of depositing large aggregate for the concrete in position and subsequently grouting this by injecting a colloidal cement. The method was entirely successful and produced sound watertight concrete. The piers were built of rubble masonry in 1:6 cement mortar and the abutments are of reinforced concrete box construction. The bow-string spans are of a special type, the hangers which carry the roadway being inclined and not vertical as is usually the case. This type of hanger eliminates all moments in the arch rib and results in a lighter and more economic construction. The spans are carried on cast-steel rocker and roller bearings.

#### NEW MASONRY DAM FOR TORQUAY CORPORATION.

The Torquay Corporation is constructing a new reservoir to augment its existing water supply. This article describes the dam forming the reservoir and other appurtenant works. The dam has been designed as a masonry structure of the gravity type straight in plan with a battered upstream face and a stepped downstream face. The overflow section of the dam is 150 ft. in length with a downstream slope of 1:1.55 finished off at the top with a parabolic curve connecting the face to the horizontal crest. The body of the dam will consist of rubble masonry consisting of granite "plums" in 1:2½:5 Portland cement concrete while the facing upstream and downstream will consist of squared blocks of granite with joints extending inwards from the face not less than 18 inches. The masonry on the upstream face will be built in aluminous cement to counteract the corrosive action of the moorland waters. Contraction joints will be provided at intervals of 50 ft. at right angles to the centre line of the dam. Sheet copper water stops filled on the upstream side with bitumen will be incorporated in the joints. In order to minimise the heat of hydration and reduce the tendency for the development of cracks in the concrete, a special coarse, low lime content Portland cement is being manufactured. An analysis of the cement is given. Other works described are the outlet tunnel, valveshaft, draw offs, river diversion works, and inspection galleries in the body of the main dam. The dam will be founded on rock and the depth of excavation has reached 40 ft. below the ground surface.

#### LOW LEVEL BRIDGES: THEIR ADVANTAGES FOR TROPICAL CONDITIONS.

McConnel.

Low level bridges which are liable to be submerged during the rainy season and in floods are discussed in this article. The general principles of design and siting of this type of bridge are described. The lateral forces to which such a bridge is subject and which must be taken account of in design are enumerated and the

factors governing the location of this type of bridge are mentioned. The most important feature to be considered in design is the determination of the size of the spans so that they are not liable to be choked with flood debris. These bridges are usually of reinforced concrete construction though timber bridges have also been adopted largely in Australia.

#### **BURNHOPE RESERVOIR OPENED.**

*See under "Water and Water Engineering", October 1937 of this Bulletin.*

#### **THE MOSCOW VOLGA CANAL.**

This is a navigation canal which has recently been opened to traffic in U. S. S. R. The important features of this scheme are described. The canal is 79.5 miles long of which 12.5 miles are across reservoirs and impounded lakes. The deepest cutting for the canal is 75.5 ft. and the highest embankment is 46 ft. The dimensions of the canal are :—

Width at water level 280 ft.

Width at bottom 151 ft.

Depth of water in channel 18 ft.

There are eight sets of locks on the canal built in reinforced concrete and fitted with electrically operated gates. Five pumping stations on the canal lift water for Moscow municipal waterworks. A number of hydro-electric stations have been built at several points for generation of power. Of the dams on the canal, three are of reinforced concrete and eight are earthfill. The most outstanding structure is the Volga Dam in reinforced concrete which is 708.5 ft. long and 85 ft. high. On account of the severe climatic conditions occurring in Russia, the concrete in hydraulic works has been protected by a coating of bitumen to withstand action of frost. The construction equipment is mentioned and brief details of important construction procedure are given.

#### **BUILDING SCIENCE ABSTRACTS.**

##### **CONCRETE: ITS MAINTENANCE AND REPAIR.**

*Am. Conc. Inst. J.*, 1937, 8. Directions for repairs to concrete roads are given herein. Waterproofing of road surfaces by painting with oil paints, waterproof varnishes and bituminous dressings is discussed. Methods of stopping passage of water through construction joints are described, and directions for the patching of concrete are given.



## THE THEORY OF SOIL CONSOLIDATION AND TESTING OF FOUNDATION SOILS.

*Pub. Roads* 1937, 18 (1). In this report several devices constructed at the U. S. Bureau of Public Roads and used for soil testing are described. The theory of consolidation of earth materials is discussed and mathematical derivations used both for the computation of earth pressures and stresses and for the computation of formulæ applicable to the consolidation of relatively impervious saturated strata caused by these pressures are introduced. One of the most useful tools in the study of soil consolidation is the laboratory compression device designed by Terzaghi. A brief description of the essential features of this device is given and typical permeability, compression and consolidation curves are presented for an undisturbed sample of compressible soil.

*No. 377—November 1937.*

## EDITORIAL.

### STEAM *versus* WATER-POWER.

Comments on the Presidential address of Mr. S. B. Donkin delivered before the Institution of Civil Engineers. A portion of the address in which he deals with the comparative values of generation of electricity by steam and water power has been quoted to show the future possibilities of water power schemes, specially if the prices of fuel continue to rise.

## FOREIGN NOTES.

Dixon.

### MODEL STUDIES FOR TIDAL ESTUARIES.

In *V. D. I. Zeitschrift* 81, Prof. Seifert discusses the results which have been obtained at the Prussian State Laboratory, Berlin, from the study of models of tidal estuaries. A model of a length of 72 miles at the mouth of the river Eider was studied in order to see the effect of providing embankments for land drainage. It was found that the restriction of the channel caused a slight rise in the high water levels and a considerably greater fall in the low water levels. This result was found satisfactory as a fall in low water levels would improve drainage. The embankments were therefore constructed. Actual observations of high and low water levels after the construction of the embankments showed that the results were in close agreement with those obtained from the models. Another investigation was in connection with the prevention of silting in the harbour of a petroleum refinery on the Lower Seine. The model reproduced the estuary for a length of 3.6 miles and was built of concrete, powdered amber being used to reproduce the silt. Tidal conditions were reproduced by two tidal generators. It was observed that a large vortex formed within the harbour on the falling tide from which silt

was deposited. This vortex formation was prevented by two groynes at the harbour entrance, their action being studied in the model. A more difficult problem now being studied is the reclamation of slob lands on the west coast of Germany. The method of reclamation selected depends on the construction of banks to form new watersheds and thus to influence the drainage of the slob lands.

#### AUTOMATIC SYPHON SPILLWAYS.

The application of model studies to the design of syphon spillways is considered by M. Hegly in *Annales des Ponts et Chaussées*, 107, 733. Investigations with models were carried out for the design of new spillways for some reservoirs near Nancy. Experiments were made with three helical syphons of one tenth full size, and one full size syphon. The models were in solid drawn steel and had bell mouthed intakes. Coefficients of discharge for the syphons were determined. The author concludes that experiments with models of syphons on scales of one fifth to one twentieth full size give satisfactory results.

#### THE KILOSA BRIDGE.

Stevenson.

This is a bridge constructed in Tanganyika territory and consists of one main span 120 ft. clear and five approach spans 34 ft. clear. The main span is of lattice girder type. The decking is of reinforced concrete. The piers and abutments are of mass concrete. The foundations of one abutment and one pier are of open mass concrete construction. The other abutment is founded on a reinforced concrete raft and four remaining piers are founded on reinforced concrete caissons. Construction operations are described in this article. Difficulties in the foundation work where running sand and water were encountered are described and the manner in which they were overcome are mentioned.

#### THE SETTLEMENT OF FOUNDATIONS ON CLAY.

Allin.

Clay and cohesive materials of similar characteristics have been partly or completely responsible for the majority of important failures of foundations and earthworks of which records exist. This is because in cohesive soils the settlement under load continues for years and is therefore difficult to determine. During the last decade research on the physical properties of clay in relation to its rate and amount of settlement under load has developed with important results. Dr. Terzaghi's work in this field is mentioned and the apparatus developed by him for testing compressibility of soil samples is described. From laboratory tests on compression, expansion, permeability, etc., of samples it is possible to make approximate predictions of the rate at

which settlements would occur in foundations on clay and other soft materials, and their ultimate value. During the earlier stages of this research clay samples were tested in a remoulded condition because of the difficulty of extracting them undisturbed from the drill hole. Later experiments with undisturbed samples indicated that undisturbed clay has greater strength and elasticity than that which has been remoulded. Assumptions and approximations which must be made in predicting settlement of structures from compressibility tests in the laboratory are discussed and conclusions drawn from the research on physical properties of clay soils are given.

#### CORROSION-RESISTING STEEL IN CIVIL ENGINEERING.

During recent years a number of low and medium carbon steels with small admixtures of alloying elements such as nickel, copper, chromium, etc., have been developed which are claimed to be highly resistant to corrosion. These are available in a wide variety of forms including plates, sheet and strip, sections and bars, tubes, castings and pressings. They are readily welded by the electric arc process. A number of applications of these products are described in this article. A very large tonnage of this kind of steel has been employed in the heightening of the Assouan Dam. Other uses mentioned are the lining of a length of the river Derwent used as the measuring channel, to prevent moss and vegetable growth, and the use of bars of this material for reinforced concrete in modern buildings. This steel was extensively used in the reconstruction of the St. Paul's Cathedral, London.

#### BUILDING SCIENCE ABSTRACTS.

##### A STUDY OF SUB-AQUEOUS CONCRETE.

*American Concrete Institute Journal*, 1937, 8. Certain studies are described to determine the comparative strengths of concrete placed in water and in air and to determine the most advantageous mix for concrete to be placed under water. Some of the conclusions are : (1) Strength of concrete placed under water is lower than that placed in air for identical mixes ; (2) mixes which would be over sanded for concrete placed in air gave relatively strong concrete placed under water ; (3) a very finely ground cement yielded higher strengths than ordinary Portland cement for concrete placed in water.

##### THE PREDETERMINATION OF THE TEMPERATURE RISE IN LARGE MASSES OF POURED CONCRETE.

*Zement*, 1937, 26. Heat losses into the atmosphere during concreting in mass concrete structures are discussed. A solution is given

in integral form for the difference between the temperature of the concrete and that of the air as a function of position and time. The equation makes allowance for the fact that as the rate of concreting is increased the heat losses into the atmosphere will diminish.

This issue contains a Public Works, Roads and Transport Exhibition Supplement, in which are given the exhibits of various firms at the London Exhibition held on November 15-20, 1937.

## CONCRETE AND CONSTRUCTIONAL ENGINEERING.

VOL. XXXII.

*No. 9—September 1937.*

### EDITORIAL NOTES.

#### THE PLASTIC THEORY.

The editor briefly reviews the development of various theories for reinforced concrete design leading up to the present standard method incorporating the modular ratio. In recent years a new theory of reinforced concrete design rejecting the modular ratio as a factor in design has been advanced. An account of some theories of this type with a detailed description of that due to Prof. Saliger have been published in this journal and discussions on this theory are being published. The editor discusses the various objections to the standard modular theory and the methods proposed to amend the theory. He then reviews the new theory and discusses the points in favour of and against it. In the end he concludes with the remark that it is yet unproved that the new theory provides a sounder basis of design than the standard modular theory.

#### THE MODULAR RATIO : A NEW METHOD OF DESIGN OMITTING *m*.

Further comments by several writers on this paper by Dr. Hajnal-Konyi in which he puts forward a new theory of reinforced concrete design, are given. Dr. Hajnal-Konyi's reply to the discussion is also given.

#### DESIGN OF DOMES.—II.

Terrington.

This article is continued from the previous issue and gives a method of designing thin spherical domes of varying thickness in reinforced concrete. An example is worked out to illustrate the method, and a graphical method of design is also given.

*No. 10—October 1937.***EXPERIMENTS WITH COLD-WORKED STEEL AS REINFORCEMENT.**

Evans.

In this paper the results are discussed of an investigation concerning the deflection and steel strain in concrete beams reinforced with either cold-worked (overstrained) steel or carbon steel of approximately the same yield strength. An appreciable increase in the yield stress of cold-worked or over-strained steel together with the adoption of higher working stresses in the reinforcement has resulted in increasing use of cold-worked steel in reinforced concrete. Tests were made with rectangular and T beams, the spans being 100 inches and 60 inches respectively. The cold-worked steel consisted of pairs of mild steel bars twisted together helically and rigidly restrained against longitudinal movement, thereby stretching the bars during the twisting operation. Particulars of the beams and reinforcements are given and the results of tests are presented graphically.

The results show that for equal stresses in the tension reinforcement the deflection and steel strains in concrete beams reinforced with cold-worked or overstrained twisted steel rods are greater than those in beams reinforced with high-tensile or carbon steel rods of the same diameter, the beams being identical except for the grade of reinforcement used.

**TIDAL SLUICES ON THE RIVER MEDWAY.**

(See page 30 of Bulletin No. 7).

**DESIGN OF DOMES.**

Terrington.

Continued from the previous issue. A graphical method of checking the designs worked out as examples in previous issues is given. Other problems dealt with are the design of flat domed roofs and conical domes.

**CONCRETING UNDER WATER AT THE STORSTROM BRIDGE IN DENMARK.**

The foundation of this bridge consists of 51 piers resting on the sea bottom. A special form of cofferdam was used for the construction of the piers but investigation of the soil at the bridge showed that for a certain number of piers it would be risky to pump out the water until the bottom had been sealed with concrete. It was therefore decided to deposit the concrete in the foundation slab of these piers under water by a special method. In this method the area to be covered is divided into sections of a suitable size so that each section can be deposited in a few hours in such a manner that the cement is not pressed out from the newly placed concrete. The division was made with shutters placed by divers who carefully tightened the joints. When the shuttering was ready a 10 inch vertical steel pipe was placed with its lower end on the bottom of the first compartment. The pipe was

supported from a platform which also carried the hopper for the concrete and winches for lifting or lowering the pipe. When concrete placing started, the end of the pipe rested on the bottom. It was then filled with concrete and subsequently lifted just sufficiently to allow the concrete to flow out. Simultaneously additional concrete from the hopper was poured in the pipe so that it was always full. The concrete was thus poured from the bottom, the first batches forming a protective surface which was raised as concreting proceeded and effectively protected the concrete underneath from the effects of the water. Twenty three foundation slabs were carried out in this manner with invariably good results.

#### THE MODULAR RATIO.

Comment on the above article by Prof. Magnel.

*No. 11—November 1937.*

#### PILING AT THE KENT CEMENT WORKS.

Taylor.

Buxton.

The Kent works of the Associated Cement Manufacturers Ltd. is built on a site consisting of marshland, and all the important buildings and machinery are carried on piles of reinforced concrete and timber. Recently the works were extended and the piles used for the extension were 16 inch square reinforced concrete pre-cast piles 50 ft. long, 147 in number. Some of the piles came to a satisfactory set with their heads above ground level while some had to be driven several feet below ground level, which necessitated the use of a hardwood dolly for driving below ground. The ultimate resistance of piles is usually estimated from Hiley's formula, but for the piles driven with the dolly this formula was found to be unsuitable and a method of assessing the bearing capacity was developed. This method is explained in some detail. Other information regarding the piling operations including results of a test on a driven pile are also given.

#### FLOW IN CHANNELS.

Hogan.

Gibbs.

The authors in a series of articles entitled "Uniform Flow in Pipes" published in this journal sometime ago, discussed flow in pipes (*See* page 20 of Bulletin No. 4 and page 18 of Bulletin No. 5). In the present series of articles, of which this is the first, they discuss flow in open channels. The two cases of flow in pipes and open channels are not so vastly different as they appear at first sight. In a pipe running partly full the slope of water surface controls the quantity discharged as in the case of an open channel. Flow in a channel is said to be uniform when the depth

and velocity of a stream, the cross section and the slope of the bed of the channel remain constant. In a river or natural water course, the conditions for uniform flow are seldom fulfilled. In the case of pipes two types of flow have been discussed namely viscous flow and turbulent flow. These can also exist in channels but viscous flow is rare. Turbulent flow can occur in either of the two forms known as tranquil or streaming flow, and rapid or shooting flow. For any particular rate of flow in a channel, there is a depth corresponding to which the total energy of flow is a minimum, known as the critical depth, which marks the transition from tranquil to shooting flow. When the depth is less than the critical depth the flow will be shooting and when more, the flow will be tranquil. The authors then proceed to explain the total energy curve of flow and the equation of the energy curve is derived from first principles. From this equation by differentiation, an expression for the critical depth has been obtained which represents the depth corresponding to minimum total energy.

The effect of a change in the level of the bed is then studied with the help of the total energy curve. The effect produced on the surface of a stream by a submerged obstacle is also studied. The energy equation can be applied to channels of non-rectangular cross sections, and this has been illustrated by deriving an energy equation for triangular channels from the general equation.

The authors then discuss the distribution of velocity in open channels. It is essentially different from that in a pipe. In open channels the distribution of velocity on vertical sections is asymmetrical and a double spiral type of motion is set up in the stream in consequence. These spiral motions have been observed by Gibson in the Mersey and in experimental channels. The effect of the spiral motion is to cause the maximum velocity to occur not at the surface but at a short distance below it. The distribution of velocity along a vertical situated at a sufficient distance from the sides for the flow to be unaffected by the friction at the sides, can be investigated by the aid of Prandtl's theory of fully developed turbulence. An expression has been obtained for the velocity at any point along the vertical. Velocities actually observed by a current meter along a vertical at one of the gauging stations of the River Severn are shown to agree very well with the velocities obtained from the equation.

#### **ACTION OF SULPHATE SALTS ON CONCRETE.**

**Abstracts from a paper read at a meeting of the Institution of Sanitary Engineers by Dr. F. M. Lea. (See Quarterly Bulletin No. 5, page 41).**

## THE ENGINEER.

VOL. CLXIV.

*No. 4262—September 17, 1937.***MISCELLANEA.****HYDRO-ELECTRIC POWER SCHEMES IN INDIA.**

The Mysore Government has approved two hydro-electric development schemes. The first is at Shimsha falls and includes a 20 mile long power channel from the balancing tank at Sivasamudram to the site of the station at Shimsha falls. The second is at Jog falls and includes a storage reservoir of 7,200 m. cft. capacity.

**THE BRITISH ASSOCIATION.**

Dr. Oscar Faber presented a paper on air-conditioning in which he discusses the details of the problems and illustrates the essentials of a modern air-conditioning plant. The paper is directed principally to the problem of producing agreeable air conditions in offices, theatres, assembly halls and other such places, in which the requirements are adjustment of temperature and humidity, and filtration. He discusses the use of ammonia and carbon-dioxide for the refrigerating plant and points out the advantages and disadvantages of both. A modern development is the use of water and water vapour as the refrigerating medium. He gives some particulars of air filters in existing air-conditioning plants and gives the values of temperature and humidity associated with conditions of comfort in office buildings.

*No. 4263—September 24, 1937.***STRAIN AND STRESS DISTRIBUTION IN DOUBLY REINFORCED CONCRETE BEAMS.**

Evans.

In this article the results of tests carried out on doubly reinforced concrete beams are discussed. The beams were loaded at the middle third points and readings were taken at zero load and at a number of increasing and decreasing loads in each cycle of loading. The strain measurements were taken by means of a mirror extensometer. The tests were made with beams of different concrete mix.

*No. 4264—October 1, 1937.*

Nothing of interest to irrigation engineers in this issue.

*No. 4265—October 8, 1937.***FEN DRAINAGE PROPOSALS.**

At a meeting of the Great Ouse Catchment Board certain proposals were considered which are planned to prevent a recurrence of the



serious flooding of the Fens which took place last spring. The schemes proposed provide for the reconstruction and strengthening of the principal river banks, increasing the capacity of certain rivers by widening and setting back of floodbanks, and strengthening of certain floodbanks by breasting with clay. Much of the above work is well in hand.

#### AMERICAN HIGHWAYS AND HIGHWAY PRACTICE.

Tratman.

This is the first of a series of articles dealing with highway practice in the U. S. A. An outline of the history of American highways is given. At the present time, there are more than 3,000,000 miles of roads comprising trunk roads, secondary roads, rural roads, and connecting links. The Bureau of Public Roads administers the Federal-Aid Road Programme in co-operation with the highway departments of the several States. The Bureau does no construction but carries on an extensive programme of research work in the field and laboratory. Modern trends in road design are described, and typical examples of road sections are given. Several types of roads as used in some of the States are described. Standard designs as adopted by some of the important States are also described.

*No. 4266—October 15, 1937.*

#### AMERICAN HIGHWAYS AND HIGHWAY PRACTICE.

Tratman.

Continued from previous issue. Express highways are dealt with in this article. A recent development in roads of the express highway type is the "freeway" which is a highway to which the owners of abutting property have no right of access and no easement of light, air, or service. The road is completely fenced except at points chosen for connection with other roads by the highway authority. Some types of super-highways are illustrated and described, and their special features are mentioned.

#### MISCELLANEA.

##### A HYDRO-ELECTRIC SCHEME IN KOREA.

Work has begun on a large hydro-electric scheme in Korea which involves the harnessing of the river Kyosonko and the construction of 5 power stations with an aggregate output of 353,000 kW.

##### THE VOLGA HYDRO-ELECTRIC SCHEME.

Preliminary work has begun on the Kuibyshev hydro-electric development scheme which is part of the general plan of building on the river Volga a system of dams and hydro-electric stations. A dam to raise the level of the river some 30 m. is to be built above the city of Kuibyshev and two power plants are to be built with a total output of 2½ million kilowatts.

*No. 4267—October 22, 1937.*

**AMERICAN HIGHWAYS AND HIGHWAY PRACTICE.**

**Tratman.**

Continued from previous issue. Highway curves and gradients as adopted in American highways are discussed in this article. Designs of intersections of highways are also dealt with.

*No. 4268—October 29, 1937.*

**AMERICAN HIGHWAYS AND HIGHWAY PRACTICE.**

**Tratman.**

Continued from previous issue. The design of road crossings is further discussed. Arterial and terminal roads and their requirements are described, and some existing examples are cited. The various classes of roads comprising a highway system of the present day are briefly described and their necessary features are mentioned. The various constructional types and methods included in the total mileage of highways in the United States are discussed.

*No. 4269—November 5, 1937.*

**EDITORIAL.**

**THE ENGINEER IN THE TROPICS.**

The editor calls attention to the need of further scientific research in respect of the laws which govern natural phenomena in tropical regions. The hydraulic engineer has a vast field of research and practical work in tropical regions which are afflicted either with excessive rainfall and floods or by very little rainfall with its inevitable consequence of arid land. Much has been done recently by hydraulic engineers in India, Egypt, China, etc., in the field of water conservation, flood prevention, and water power utilization, but much more remains to be done.

**FLOOD CONTROL AND STREAM FLOW REGULATION.**

**Williams.**

This is an abstract from a paper presented before the Institution of Sanitary Engineer and deals with some aspects of the question of river control. Certain suggestions are made for works on the Thames and Severn catchments, which illustrate the nature of the problems involved. After describing the physical characteristics of the Thames and Severn catchments, and the rainfall, the author passes on to the question of flood control. He discusses the effects of flood control by embankments on the river bed and on flood levels. Factors to be carefully considered in flood control by storage reservoirs include, proper siting, capacities of reservoirs, and the question of their economic feasibility. He considers it doubtful if large reservoirs for flood control alone can be an economic proposition in England, and says that they must serve other purposes as well in order to make them economically justifiable. The article is to be continued in the next issue.

*No. 4270—November 12, 1937.*

**AMERICAN HIGHWAYS AND HIGHWAY PRACTICE.**

**Tratman.**

This article deals with various methods of construction adopted on American roads. Some features of earthwork for highway construction are described and the construction of concrete roads is treated in greater detail. Compacting the concrete by electric and pneumatic vibrators is used extensively. Conclusions arrived at with regard to the use of vibration from tests conducted by the United States Bureau of Public Roads are given. Stages in the construction of a concrete highway are described and illustrated. Various types of longitudinal and transverse joints used are depicted and briefly described. The methods of curing the concrete are also mentioned.

**FLOOD CONTROL AND STREAM FLOW REGULATION.**

**Williams.**

Continued from previous issue. The author outlines preliminary computations necessary in the investigation of reservoir sites and capacities. The relationship between the capacity of a storage reservoir and the rate of discharge that can be maintained from it is discussed, and curves for this relationship applicable to British upland catchments are reproduced. Off-flow curves for various catchments are given from which the normal annual run-off for catchments with different annual rainfall may be computed. The maximum flood at any point in a catchment may be produced either by very intense rainfall on a comparatively small area or by long continued rainfall over a large area. The author explains the method of computing peak flood discharge over a catchment for intense rainstorm and gives formulæ developed for peak rates of flood flows on Thames and Severn catchments. He then describes the possible reservoir sites on the Severn and the Thames which have been investigated and are found to be the most promising. He gives the total capacity of each reservoir, the storage capacity that would be reserved in each reservoir for regulating the flow of rivers, the estimated mean annual off-flow from the catchment to the reservoir, and the constant discharge that could be maintained from it. He also gives estimated inflow to and outflow from the proposed reservoirs in probable maximum floods which show that they would be very effective in reducing the intensity of local floods.

**NEW HYDRO-ELECTRIC POWER STATION IN JAPAN.**

**Taji.**

The Shinano, the largest river in Japan is to be utilized for the generation of power. A new hydro-electric power station is now under construction where five sets of 60,000 H. P. water turbines and 31,000 K. W. alternators are to be installed. Brief details of the turbines and alternators are given.

*No. 4271—November 19, 1937.*

**AMERICAN HIGHWAYS AND HIGHWAY PRACTICE.**

**Tratman.**

Continued from previous issues. Roads paved with vitrified bricks are described, and the manner of laying the brick, paving and filling in the joints are briefly outlined. Specifications in use for brick pavement construction and standard dimensions of bricks are given. Bituminous pavement construction as practised is then described in some detail. Proportions of graded stone, sand and asphalt used for the base and top courses of a Michigan highway are given as a typical example of mixtures used. Some features of new types of bridges which have been built on the new roads are then briefly discussed.

*No. 4272—November 26, 1937.*

**AMERICAN HIGHWAYS AND HIGHWAY PRACTICE.**

**Tratman.**

Concluded in the present issue. This article deals with highway illumination, highway signs and guards, and landscaping as existing on American highways.

*No. 4273—December 3, 1937.*

**PRESERVATION OF THE NILE.**

**Newhouse.**

The Blue Nile is the chief source of water in Egypt and the Sudan. Practically the whole of the catchment area of the Blue Nile is in Abyssinia and consists of a savage and sparsely populated country covered with forest, scrub and grass. Under Italian control, the development of this tract is likely to be hastened. The author, who was late Inspector General of Irrigation in the Sudan, discusses in this article the future effect of the development of the catchment area of the Blue Nile in Abyssinia on the regime of the river and on present irrigation conditions in Egypt and the Sudan. In the words of the author "if Abyssinia becomes quiet and peaceful, and the cattle and goats increase, the mountains and plains will be denuded of trees and grass, the country side will be torn to bits by torrents, the discharge of the Blue Nile will be a monstrous torrent every year, and its whole regime will be altered to the certain detriment and possible ruin of Egypt". The present conditions of flow of the Blue Nile and the flood period are described. With a denuded catchment area, the rainfall would result in a 100 per cent. run-off as soon as it occurs; there would be no absorption and subsequent seepage as at present, and in the three winter months of January, February and March, the river might be quite dry. The silt content of the river in flood is likely to be much larger than at present and the reservoirs on the Nile would be choked with silt in a comparatively short time. The Aswan reservoir at present takes three months to fill with the comparatively silt-free waters

of the falling Nile flood but in future the flood will drop away like a stone so that reservoir filling operations will be made almost impossible to carry out. Over and above all these changes the question of flood protection will become more serious and urgent. The denudation of the catchment in Abyssinia would double the total run-off of the Blue Nile by increasing it from 20 per cent. of the rainfall as at present to 40 per cent. The author suggests that the obvious thing to do is for Egypt and the Sudan to invite Italy's attention to the matter and to arrange for some of their engineers to study the technique of anti-erosion measures first-hand in America so that steps may be taken to prevent the ruin of the Blue Nile catchment in Abyssinia, which will mean a great disaster for Egypt and the Sudan.

#### THE PUBLIC WORKS EXHIBITION.

Some of the exhibits are described, which include a mechanical shovel. The machine is mounted on a specially built lorry chassis, the power unit of which also provides power for the operation of the excavating functions. Another exhibit was a new type of electric concrete vibrator.

*No. 4274—December 10, 1937.*

#### THAMES FLOODS.

Newhouse.

In this article are discussed the causes of floods on the Thames, their probable intensities, and possible measurements of protection. The Thames is divided into two distinct sections by the Weir at Teddington which marks the limit of tidal effect on the river. Floods above Teddington are caused by rain and snow on the catchment. From data of widespread rainstorms in the past in England, a rainfall of 3 inches in 24 hours on an area of 2,000 sq. miles is possible. Records of rainfall and run-off in the Thames Valley show that run-off in January and February averages 62 per cent. of the rainfall, it is reasonable to assume that this might be as high as 80 per cent. in long wet spells when the ground is saturated. In that case the discharge due to a 3 inch rainfall in 24 hours would be 40 million gallons per day past London bridge. This would be in addition to the normal quantity passing over Teddington Weir; the maximum ever recorded being 20,000 million gallons. The total possible discharge would thus be 60,000 million gallons a day. On January 6th and 7th, 1928 there was a very disastrous flood in the Thames which caused serious damage and loss of life, yet the estimated discharge of that flood was only 12,500 million gallons, or one-fifth of what might be expected in an exceptional year. Below Teddington weir the conditions are still more aggravated by the tide factor. At present, each county along the river is responsible for protecting its own length of water line. The disadvantages of this procedure are discussed and the necessity of one central authority for flood control operations on the whole river is emphasized.

## JOURNAL OF THE INSTITUTION OF CIVIL ENGINEERS.

*No. 8—October 1937.*

## MODERN METHODS OF STRUCTURAL DESIGN.

Baker.

This is the Institution Lecture to students for 1936-37 and deals with recent developments incorporating new ideas in the design of structures. Prof. Hardy Cross' new method of stress analysis is briefly outlined and its application is illustrated with reference to a cantilever frame. Principles in the design of stanchions and beams are discussed and an outline of the new method of design is given in each case.

## CORRESPONDENCE ON PAPERS.

THE RESTORATION OF THE BREACH IN THE RIGHT  
GUIDE BANK OF THE HARDINGE BRIDGE.

Correspondence on the above paper which was published in the November 1936 issue of the journal (See Bulletin No. 6, page 41) Mr. C. C. Inglis of Poona refers to the model experiments in progress at the Khadakvasla Hydrodynamic Research Station in connexion with safeguarding the Hardinge Bridge, and says that it has been possible to reproduce the breach accurately, although the author of the original paper has stated that the actual cause of the breach will remain an unsolved problem. He goes on to discuss the cause of the breach and criticizes the construction of the Damukdia guide bank which was undertaken as an emergency measure. Some conclusions drawn from the experiments at Khadakvasla are given and it is suggested that the basic principles of Bell and Spring with regard to river control, though sound, required revision and amplification in the light of present knowledge. The author in reply to Mr. Inglis' remarks says that the Damukdia bund was built after the considered opinion of very many engineers had been taken, and was now being extended. He thought that the model experiments carried out by Mr. Inglis had given, and would continue to give, most valuable information with special reference to specific details such as pitching of piers, launching of aprons, etc. He felt however that over an extended length of 50 miles of an alluvial river where so many factors were involved, the investigation of the behaviour of a river like the Ganges by means of a model was not perhaps the best method; experience together with observation, combined with common sense and an application of general hydraulic principles, could supply the knowledge necessary for designing training works, aided perhaps in matters of detail by knowledge acquired from model experiments.

### THE LOWER ZAMBEZI BRIDGE AND THE CONSTRUCTION OF THE LOWER ZAMBEZI BRIDGE.

These two papers were published in the January 1937 issue of the journal (See Quarterly Bulletin No. 5, pages 37 and 38). Comments on these papers are concerned with the depth of foundations of the bridge piers, skin friction in the design of pier well foundations, sinking of wells, well curbs, and economical length of spans.

### THE SECOND-STAGE DEVELOPMENT OF THE LOCHABER WATER-POWER SCHEME.

This paper was published in the February 1937 issue of the journal (See Quarterly Bulletin No. 5, page 39). Comments on this paper refer to cracks in concrete dams, construction joints, the use of gunite on the upstream face to deal with the problem of cracks due to shrinkage and temperature stresses, various methods of prevention of permeable shrinkage cracks, grading of aggregates for mass concrete dams, and siphon spillways.

### FLOOD-HYDROGRAPHS.

This paper was published in the March 1937 issue of the journal (See Quarterly Bulletin No. 6, page 44). Comments are mainly directed to the formulas proposed in the paper and the catchment areas to which they are applicable.

### THE FLOW OF THE RIVER SEVERN, 1921—36.

This paper was published in the June 1937 issue of the journal (See page 43 of Quarterly Bulletin No. 7). Mr. Griffith points out that the best method of measuring and recording discharges depended on the local conditions and gives his experience with the discharge observations of the Sarda River at Tunakpur in the United Provinces. He gives a method of obtaining a stage discharge curve and discusses the gauging of the Great Ouse and its tributaries, for which he was responsible.

Mr. Gerald Lacey of Roorkee states that though meters are accurately rated the discharge by the cup type meter was 1.5 per cent. greater than by the screw type meter. In India the use of current meters in measuring canal discharges is steadily increasing. Adjustable velocity rods are still largely used in the United Provinces, Bombay and Sind and they gave the mean velocity in a vertical with considerable accuracy. In India, for many years to come reliance in river flood discharges would of necessity be placed on central surface velocity observations with floats.

Correspondence on the following papers is also published :—

**SIMPLE EXPERIMENTAL SOLUTIONS OF CERTAIN STRUCTURAL DESIGN PROBLEMS.**

**SHIP CANALS UTILIZED FOR DRAINAGE.**

**EFFICIENCY TESTS OF LARGE MODERN PELTON WHEELS.**

**PRE-STRESSING BRIDGE GIRDERS.**

**THE SALONIKA PLAIN RECLAMATION-WORKS.**

**THE LAKE COPAIS, ITS DRAINAGE AND DEVELOPMENT.**

**APPLICATION OF VIBRATION TO THE PRE-CASTING OF CONCRETE.**

**KINCARDINE-ON-FORTH BRIDGE.**

*No. 1—November 1937.*

**PRESIDENTIAL ADDRESS.**

Mr. Sydney Bryan Donkin, President of the Institution for the coming year, dealt with developments in electricity in his address. A comparison is made between the methods of generating electricity by steam, oil and water power. He states that where the load factor is high and peak load can conveniently be dealt with, hydro-electric schemes can be used economically.

**A PRE CAST REINFORCED-CONCRETE UNDERLINE RAILWAY BRIDGE.**

Follenfant.

This paper deals with the design, construction and erection of a reinforced concrete underline railway bridge carrying the Piccadilly line of the London Passenger Transport Board over the ticket hall of the reconstructed South Harrow station. The noteworthy feature of this bridge is that it was constructed complete in a temporary position adjacent to the tracks and was rolled into position. The bridge has a span of 41 ft. 9 inches and consists of six T beams at 3 ft. 9 inch centres supporting the deck slab. Five transverse beams are provided for lateral stiffness and to equalize the deflexion amongst the longitudinal T beams. Details are given of construction, erection, progress of work, quantities, etc.

**IMPROVEMENTS IN THE HARBOUR OF PORT LOUIS, MAURITIUS.**

Austen.

Harbour improvement works at Port Louis comprising dredging, reclaiming a shallow part of the harbour, and building deep water quays are described in this paper. The area reclaimed was a large patch covered with mud and sand with an average depth of 6 ft. of water. A rubble embankment was first built enclosing the area and a masonry faced parapet wall on a reinforced concrete



slab foundation was built on the rubble embankment to retain the dredged material, which was deposited behind the embankment. The deep water quays were built on reinforced concrete piles 14"  $\times$  14" square and 55 ft. long.

**THE RECONSTRUCTION OF THE INCHCAPE BRIDGE,  
BENGAL AND NORTH WESTERN RAILWAY.**

Ravenhill.  
Wilson.

This railway bridge on the Gogra River in Bihar consists of eighteen 200 ft. through-girder spans on brick piers founded on circular brick wells sunk 97 ft. below low water level. The piers are 36 ft. high above low water level. In the Bihar earthquake of January 1934 two of the girders were overthrown and fell into the dry bed of the river. The reconstruction of the two damaged spans is described in this article. For one of the damaged spans, an exactly similar span of a disused bridge about 200 miles away was used, and the other span was made up from the undamaged members of the two fallen spans.

**THE REDUCTION OF CARRYING CAPACITY OF PIPES WITH  
AGE.**

Colebrook.  
White.

"This paper outlines a theory based on the Von Karman-Prandtl resistance law together with the hypothesis that the hydraulic deterioration of pipes is due to increase in surface roughness, and that the size of the roughness irregularities grows in direct proportion with time. A formula is developed giving the relation between the age of a pipe and its carrying capacity and a tabular statement gives the rate of growth of irregularities under various conditions."

**THE DISCHARGE OF SMALL SUBMERGED SHARP-EDGED  
ORIFICES.**

Cornish.

The experiments described in this paper were carried out with the object of discovering whether the co-efficient of discharge of a submerged orifice is affected by the value of the head on the downstream side. A brief description of the apparatus used is given and the results are discussed. The results of other investigators are compared with the results obtained by the author and the following conclusions are arrived at:

1. At Reynold's numbers less than 3,500 the value of the downstream head has a considerable influence on the co-efficient of discharge of a square submerged orifice which is therefore unreliable as a measuring device within this range.
2. At Reynold's numbers higher than 3,500 the value of the downstream head has a negligible effect provided that the dimensions of the orifice are small compared with those of the cross section of the channel into which it discharges.
3. A rise in temperature from about 50°F. to 95°F. results in a decrease in the co-efficient of discharge corresponding to the same Reynold's number.

## WATER AND WATER ENGINEERING.

Vol. XXXIX.

*No. 480—Midsummer 1937.*

(Special Institution Number.)

BELLMOUTHED WEIRS AND TUNNEL OUTLETS FOR THE  
DISPOSAL OF FLOOD WATER.

Binnie.

The usual method adopted for the disposal of flood water from a reservoir formed by a dam is the construction of a weir over which the water flows into a channel leading to the stream below the dam. Owing to unsuitable configuration of the ground this means of disposing flood water may be very costly and in such cases an alternative method has been adopted whereby the water after passing over a weir of suitable length falls down a shaft into a tunnel discharging into the stream below the dam. The shafts at their intakes are shaped as bellmouths and this type of overflow is called a bellmouth overflow. The author in this article describes a number of bellmouth overflows built in England, America, China, New Zealand, and Singapore. Particulars of designs of these overflows are given in a table. Experiments with models carried out in connection with the design of some of these overflows are described and discussed. The experiments deal with the effect of entrained air, formation of vortex, influence on the vortex of a symmetric approach, influence of fins on the bellmouth, influence of radial piers, and influence of a curtain wall dividing the bellmouth into two semi-circular weirs. The model experiments in connection with the overflow of the Jubilee Reservoir in Shing Mun, China, are treated in greater detail. Conclusions arrived at from the study of the experiments are given, of which some of the important ones are as follows:—

1. Model experiments can predict approximately the behaviour of the prototype provided that the model ratio is not too small.
2. A steadier flow at high rates of discharge is obtained by using a conical shaft than with the type hitherto adopted.
3. A curtain wall extending across the waterway so as to divide the bellmouth into two semi-circular weirs is the best anti-vortex device.
4. The cross sectional area of the channel of approach should be such as to limit the tangential velocity to 3.5 ft. per second at any cross section.

*No. 484—October 1937.*BURNHOPE RESERVOIR: DURHAM COUNTY WATER  
BOARD.

This reservoir which is situated at the extreme western part of the county of Durham has recently been opened. It is a water supply project consisting of a reservoir, eight miles of catch water

drains and other appurtenant works. A brief history of the project is outlined and the works are described. The reservoir is formed by an earthwork embankment 1,770 ft. long, 131 ft. high, and 800 ft. wide at the toe. There is a puddle core and a concrete cut-off trench 6 ft. wide with an average depth of 95 ft. The catch water drains consist of concrete and cast iron pipes varying in diameter from 15 inches to 48 inches with branch pipes to intakes. The eight miles of catch waters bring in an additional catchment area of 5,500 acres, the total catchment area being 9,980 acres. A tunnel diversion had to be constructed for diverting the river during the construction of the dam. The overflow works consist of an overflow weir, a bellmouthed swallow hole, and a tunnel. All these works are briefly described.

#### **WATER SUPPLY OF BIRMINGHAM.**

Principal features of the existing water supply works for Birmingham are described. These works include three solid masonry dams for storage and  $73\frac{1}{2}$  miles of aqueduct to carry the water to Birmingham. The dams are 610 ft., 528 ft. and 513 ft. in length, and 122 ft., 123 ft. and 120 ft. high respectively. The aqueduct consists of conduits and inverted syphons. The conduit lengths comprise about 12 miles of tunnels, and two longest being  $4\frac{1}{4}$  miles and 2 miles long. The conduit is carried on masonry aqueducts across several minor valleys. The larger valleys are crossed by syphons, the longest being  $17\frac{1}{2}$  miles in length across the Severn Valley.

#### **EVAPORATION.**

Bilham.

Methods of measuring evaporation losses, and recent investigations on the subject of evaporation are discussed in this article. In reviewing the practical significance of evaporation data, the author emphasizes the fact that actual losses may stand in very little relationship to the rate of evaporation as measured by an evaporimeter. Under natural conditions loss of moisture depends not only on temperature, humidity, and rate of movement of air, but also on rainfall. He illustrates his remarks by considering the run-off data of the drainage area of the River Thames at Teddington. A series of graphs showing rainfall, run-off and loss calculated rainfall minus run-off in the Thames drainage area for the years 1922 to 1934, and another showing evaporation from a tank at Camden Square are depicted. A comparison of the graphs shows that the one depicting loss is altogether dissimilar from the one showing evaporation at the Camden Square tank. They also indicate that actual evaporation is high in wet years and low in dry years which is contrary to what might generally be expected. The author has also advanced a formula for run-off from the Thames drainage basin derived from a study of the rainfall and run-off data.

*No. 485—November 1937.*

#### **DETERMINATION OF THE YIELD OF WATER-BEARING STRATA.**

“From experiments carried out by the U. S. A. Geological Survey it has been concluded that with the ‘Thiem’ method of calculating permeability of water bearing earth, pumping can be successfully utilised for determining the specific yield of a water table and that figures for both permeability and pumping can be derived from the same observations and at the same time. The experiments in question were conducted over a large area of sand and gravel by means of 80 borings of varying diameter disposed in six lines spaced radially and extending some 1,055 ft. from a well from which water was raised and measured. From curves plotted, rise and fall of level and amount of discharge in the sand and gravel strata could be ascertained”.

Conditions necessary for a satisfactory application of the method are given.

#### **VARIATION IN LOSS OVER CATCHMENT AREAS.**

Lloyd.

This article discusses a method of assessing loss by evaporation, transpiration and percolation that occurs on catchment areas in the British Isles in annual periods. Variations in loss over any catchment area can be associated with the variation in rainfall, temperature, sunshine and the geological strata. The author has produced a diagram in which variations in loss are related to variations in rainfall and temperature. He has obtained statistically the values of percolation per annum in inches for various kinds of strata. He also assumes a value for the variation of loss per 100 hours' departure from a standard number of hours sunshine. Given the data regarding average annual rainfall, normal temperature, the geological strata, and the hours of sunshine for an area, an approximate value of the loss can be computed with the aid of the diagram produced. Several examples are worked out to illustrate the method. The author mentions that this method is intended to arrive at a near value of the loss in the preliminary examination of an area for which no reliable records for stream flow are available. The exact loss can only be obtained from stream flow records owing to the number of factors involved.

#### **THE BILLS BROOK DAM.**

A brief description of the dam and the work done under the first and second contracts is given. The dam forms a reservoir on a branch of the Farmington River in Hartford, U. S. A. and was constructed for the Hartford Water Bureau. The dam is a curved earth-fill embankment with a concrete core wall, 2,075 ft. long, 137 ft. high and having maximum base width of 900 ft. The

top width is 84.5 ft., and the freeboard is 15 ft. The upstream slope varies from 1 :  $1\frac{1}{2}$  to 1 : 4 and the downstream slope varies from 1 :  $1\frac{3}{4}$  to 1 : 3. The upstream face is covered with rip rap and a tile drainage system is provided in the downstream portion. A concrete conduit extends through the dam and provides for delivery of compensation water to Farmington river.

#### RAINFALL, RUN-OFF AND LOSS IN THE THAMES BASIN.

Bilham.

The author refers to his article on evaporation in the previous issue of this journal and gives a revised formula for run-off from the Thames drainage basin which is based on more extensive data than was taken account of in the formula given in the original article.

*No. 486—December 1937.*

#### EDITORIAL NOTES.

##### INFLUENCE OF FORESTS ON RAINFALL.

The influence of forests on rainfall is a debatable subject. A correspondent to the *Times* however supports the view that rainfall is influenced by forests and cites the cases of the islands of Zanzibar and Pemba in the Indian Ocean. In comparison with decrease of rainfall on the ascending coast of the mainland, Pemba should have a lower rainfall than Zanzibar whereas it is 13 in. greater due to the influence of its forests.

##### WEATHER AND WATER SUPPLY.

Bilham.

Certain aspects of the study of past weather in relation to average conditions and variability, which are of vital importance to the water undertaker are discussed in this paper. Variation of rainfall in England during the past 37 years is studied and conclusions are drawn as to what may be expected in the future. Run-off in the Thames and Severn Valley are studied in some detail and formulæ for run-off derived from statistical analysis of available data are given. Variations in losses due to evaporation in these catchments are discussed. Water engineers usually adopt 80 per cent. of the normal as the rainfall of the three driest consecutive years in estimating the reliable yield of a catchment area. This figure of 80 per cent. is borne out by the results of studies of the drought period 1932—1935.

#### INLAND WATER SURVEY : SECOND ANNUAL REPORT (1936-37) OF THE COMMITTEE.

Extracts from the Report which has recently been issued are given. The progress of work concerning survey of underground water, work of Catchment Boards, recording of rainfall and preparation of rainfall maps, and preliminary examination of

individual river basins is described. Descriptions of the features of the basins of the rivers Ness, Tay, Ouse, Severn, Dee and Irvine, are given.

#### MONTHLY REVIEW OF CURRENT LITERATURE.

METHODS OF LOCATING SALT WATER LEAKS IN  
WATER WELLS. Water Supply Paper 796-A of the  
United States Geological Survey.

Lavingston.  
Lynch.

Contains illustrated description of methods for determining place and extent of salt water leakages into wells in Texas and Florida. Four general methods are used. In the pumping method samples taken at measured time intervals while the well is being pumped show by their progressive change in salinity if salt water is being drawn in. In the velocity method suitable for use in artesian wells only, a current meter is lowered into the well and levels at which there are changes in the rate of upward movement of water are determined. These indicate possible salt water leaks. In the sampler method samples of water from different depths are analysed for chloride content. The electrical conductivity method is based on the fact that increase in conductivity is directly proportional to the increase in dissolved solids. Procedure and results of investigations are detailed. Proper construction to guard against salt water trouble is described.

LEAKAGE FROM ALBANY RESERVOIR STOPPED BY  
NEW DESIGN. Water Works Engineering, Sep-  
tember 29, 1937.

Smith.

Describes the method adopted in lining the distribution reservoir of the Albany water supply system to stop leakage. The lining is a combination of reinforced concrete and gunite to an overall thickness of 8 inches. Details of joints of slab units, and of slope joints are given.

#### VIZUGYI KOZLEMENYEK.

(In Magyar but containing English summaries).

#### VOLUME XIX.

*No. 1—January-March 1937.*

SOIL PROBLEMS IN EGYPTIAN IRRIGATION.

Kotzmann.

With the basin system of irrigation practised in Egypt before the present perennial system, salt accumulation in the upper layers of the soil was prevented by annual flooding of the basins. Since the introduction of the perennial system with canals at high levels running throughout the year a constant rise in the ground water

level in the Nile Valley has taken place. Free evaporation from this high water table takes place giving rise to salt accumulation near the surface. The soils which thus deteriorate are classified as black alkali soils and gypsum veined soils which are both impermeable to water. The reclamation of these deteriorated soils is a difficult problem. The installation of an intensive drainage system will help much but only as a preventive measure and special treatment is required for soils already deteriorated. Gypsum has some effect on black alkali soils while deep ploughing helps in the amelioration of the gypsum veined soil.

**REGULATION OF THE KOPPANY BROOK ; ECONOMIC CONSEQUENCES.** Mantuano.

This brook was regulated in 1930-33 and as a result certain areas were reclaimed. The article compares the value of the increased production with the cost of the scheme and concludes that the regulation has been an useful investment.

**DEVELOPMENT OF IRRIGATIONS IN 1936 ON THE TERRITORY OF THE LOWER-FEHERKOROS LEVEE COMPANY.** Kienitz.

Describes irrigation operations on the territory of the levee company. Irrigation was carried out by pumping from the river with water wheels and centrifugal pumps. Costs of irrigation, and income, are given.

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**DEMAG NEWS.**

VOLUME XI, B.

*No. 2—August 1937.*

Contains nothing of interest to irrigation engineers.

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**REVUE GENERALE DE L'HYDRAULIQUE.**

(In (French.)

*No. 16—July-August 1937.*

**I.—UTILIZATION OF THE PIEZOELECTRIC EFFECT OF QUARTZ FOR THE STUDY OF WATER HAMMER IN FULL PIPES.**

**II.—DEVICE FOR THE INSTANTANEOUS MEASUREMENT OF THE VARIATIONS OF DIAMETER OF THE PIPES.**

**APPARATUS FOR THE MEASUREMENT OF THE FORCE OF WAVES.**

## EXPERIMENTS, ON A REDUCED MODEL, WITH A SECTOR GATE.

### *Conclusion.*

The experiments which are described in this article show how valuable is research on reduced models for studying the problems of works with complex phenomena which are not easily susceptible of theoretical solution. They have permitted investigation of the forces required to manipulate the gate, the stability of the gate itself and the balancing couple, and several problems connected with the flow of the water, and the joints between the gate and the masonry.

## HOW TO CHARACTERIZE THE INTRINSIC VARIABILITY OF RAINFALL.

The author of this article gives the result of an important analysis of the data from the pluviometric stations at Versailles, Lyon and Marseille. These interesting researches indicate that it is possible to apply in pluviometry in temperate regions the law of proportional effect.

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## TRAVAUX.

(In French.)

*No. 54—June 1937.*

### THE CONTROL OF CEMENT QUALITIES.

Bolomey.

In this article the author reviews and discusses the use of various tests to which a cement can be subjected. He examines in great detail the tests for mechanical properties, and describes a new method for their determination.

### RE-INFORCED CONCRETE STRUCTURES. DOES THE USE OF RAPID HARDENING CEMENT INCREASE THE COST TO ANY APPRECIABLE EXTENT ?

*No. 58—October 1937.*

### STUDY OF THE REMOVAL OF ALLUVIA FROM THE HEAD OF A CANAL BY SCOURING APPARATUS, AND VERIFICATION OF THE RESULTS OBTAINED ON A REDUCED SCALE MODEL.

Bonnet.  
Blockmans.  
Lamoën.

The general conclusion from the tests described is that the nature of the materials employed is of little concern, but the important factor is the period over which flow is allowed to take place.



**THE GIRDER WITHOUT DIAGONALS FOR RIGID STRUCTURES. (VIERENDEEL GIRDER).**

Baes.

The article gives details of design of this type of girder.

**METHODS OF THE STUDY OF WAVES.**

Larras.

This describes the methods used to study wave action in connection with the design of jetteis, etc.

**THE EMPLOYMENT OF METAL SHEET-PILING IN COAST PROTECTION WORKS.**

**AGRICULTURE AND LIVE-STOCK IN INDIA.**

**VOLUME VII.**

*Part VI—November 1937.*

**THE BIOLOGICAL CONTROL OF INSECT PESTS.**

Isaac.

Insect pests injurious to crops are usually controlled by a variety of ways which may be classified as mechanical, cultural, chemical and biological. The biological method of control is based on the fact that insects are very often checked in their multiplication by other organisms which are their natural enemies. In this article the author describes some of these organisms and gives a brief review of biological control of insect pests as attempted in various countries.

**A NOTE ON COMPOSTING ORGANIC MATTER BY THE USE OF CHEMICAL STARTERS.**

Gadgil.

Hegdekatti.

This article embodies results of experiments undertaken to prepare organic manures by the use of different types of chemicals as starters. The need for this method was felt for localities where, due to the paucity of cattle, their excreta are not available for composting organic matter. The trials were made with dry and fallen leaves, twigs, rice husks, betel husks, rice straw, etc. It was found that in the absence of cattle, organic wastes could be composted with chemicals. Ammonium sulphate with calcium carbonate was found to act very effectively. Though this method is not cheaper than the method of composting with cattle excreta, it has some advantages amongst which may be mentioned the following :

- (1) It is a much quicker method, taking only about three months as against ten months required for the usual method.
- (2) It yields a final product very much superior to that given by the cultivator's method.
- (3) The presence of lime in the product is good for acidic soils.

Economic quantities of the chemicals necessary are given and costs are also worked out.

## CURRENT SCIENCE.

## VOLUME VI.

*No. 4—October 1937.*

Contains nothing of interest to irrigation engineers.

*No. 5—November 1937.*

## LETTERS TO THE EDITOR.

## ASSIMILATION OF ATMOSPHERIC NITROGEN BY GERMINATING PEAS.

It is reported that in the course of certain studies carried out in the department of bio-chemistry, Indian Institute of Science, Bangalore, definite evidence has been obtained to the effect that there is direct assimilation of nitrogen from the air by germinating peas. Some of the quantitative results obtained are given and it is mentioned that further investigations are now in progress.

## TESTING LABORATORY EXPERIMENTS ON MORTARS AND BRICK PIERS.

A series of investigations recently undertaken in the Testing Laboratory of the University College of Engineering, Bangalore, on brick piers, lean cement mortars, and composite mortar are mentioned, and some of the more important results are summarized. Tensile and compressive strengths against period of setting for mortars of neat cement to mortars upto 1 in 10 proportions are being investigated. Some of the results obtained are mentioned below :

- (1) Lime mortar of 1 to 2½ proportions mixed with 10 per cent. of cement by volume shews an increase of compressive strength by 200 per cent. and of tensile stress by 50 per cent.
- (2) Strength of a brick pier with minimum thickness of joints of 1/8" with 1 to 3 lime mortar is much less than with cement mortar of even 1 to 10 proportion.

## THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

Sabharwal.

A short history, with an account of the present activities of the Institute is given herein. The Wood Technology Section, Timber Seasoning Section, and Timber Testing Section are carrying on useful work on timber as a building material. Information and advice on matters connected with timber are available at the Institute.

*No. 6—December 1937.***WATER REQUIREMENTS OF CROPS.**

Tamhane.

Iyengar.

Chandnani.

Investigations were carried out in Sind to determine the exact water requirements of different crops in the Lloyd Barrage area. The investigations were concerned with the following aspects of the question :

1. Minimum quantities of water needed to produce normal yields of the more important crops.
2. The mode of distribution of the total quantity of water required by the crop during the growth of the crop.
3. The effects of a larger or smaller supply of water than the optimum.
4. The effect of different total quantities of water on soil and plant performance.
5. The optimum soaking doses.

The results of some of these investigations are given in this article. The experiments were conducted with two varieties of wheat and two varieties of cotton and covered a period of seven years. Duties of 100 for kharif and 200 for rabi were taken as standard for purposes of comparison as recommended by the Baker Lane Report. The yield obtained with different quantities of water is tabulated. The experiments show that duties of 100 for cotton and 200 for wheat are the optimum and cotton is definitely benefited by a more intensive supply of water during the later stages of its growth than with an even distribution at equal intervals of time.

**INDIAN AND EASTERN ENGINEER.**

Vol. LXXXI.

*No. 4—October 1937.***TRENDS IN DAM DESIGN, PART I.**

Johnstone Taylor.

This is the first of a series of three articles in which present day tendencies in the design of dams are discussed. Recent studies and investigations have placed the problem of the design of dams on a more scientific basis. The mass concrete gravity dam of the present day with modern facilities of mixing and placing concrete is a cheaper and safer structure as compared to its predecessor of cutstone masonry construction. The arch dam came into being as a result of an attempt to evolve a type of structure more economical than the gravity dam. Some important factors in the stability of mass gravity dams which have come to light in recent years are discussed. These include uplift pressure, sliding action, and

seepage. A few typical examples of gravity dams of recent construction are mentioned and their main features described. Amongst these are the Laggan Dam of the Lochaber water power scheme, the dams of the Galloway water power scheme, the Chambon dam in France and the Mettur Dam in India. The Chambon Dam is the largest dam of its type in Europe being 450 ft. high. The author also mentions that although designated as barrages, such structures as the Lloyd Barrage in Sind, and the Nile Barrages are in reality dams of no mean height with problems in design and construction similar to those encountered in the case of dams, though serving a different purpose.

#### REGIONAL WATER SCHEME COSTING £45,000,000.

The principal details of the Los Angeles Aqueduct (Colorado River Aqueduct) which is designed to convey water from the Colorado River to towns in Southern California are given herein. The Parker Dam is under construction across the Colorado River at a point 155 miles below Boulder Dam. It is proposed to construct the headworks and intakes for a 239 miles long trunk aqueduct at Parker Dam. The aqueduct comprises 46 tunnels averaging a total length of 85 miles, 75 miles of concrete lined open channels, 55 miles of concrete conduits in open cut, and 24 miles of siphons. The longest tunnel will be 13 miles in length. There will be 5 pumping stations for lifting the water to the high lands for which it is intended. The plant at each station is intended to be of nine units, each with a capacity of 200 ft. sec. the lift ranging from 150 ft. to 440 ft. (Also see page 79 of Bulletin No. 7.)

#### METTUR HYDRO-ELECTRIC DEVELOPMENT.

Dorai Rajan.

The first stage of the Mettur Hydro-Electric Scheme will be completed in October. This article describes in brief the scheme as completed so far and gives a few interesting details regarding the power house and the generating plant. The next big scheme under contemplation by the Madras Government is the Papanasam Hydro-Electric Scheme in the Tinnevely District which is estimated to cost about 2 crores of rupees.

#### STEEL RESEARCH LABORATORIES AT JAMSHEDPUR.

The Tata Iron and Steel Company have recently opened their new Technical Control and Research Laboratories which are the first of their kind in India. Details of the building housing the laboratories and their equipment are described. Testing of metals and other research work connected therewith will be carried out at the laboratories.

#### IRRIGATION IN INDIA.

A review of the press note of the Government of India published recently dealing with the progress of irrigation in India. Some facts and

figures regarding the extent and importance of irrigation works in India which are not known to many are presented in this note. One sixth of the total crops produced in British India is irrigated by the irrigation systems constructed during the British Administration. The area irrigated in India exceeds the combined total of that in the six countries which stand next amongst the world's largest irrigating countries. There are about 79,000 miles of Government channels irrigating over 40 million acres in British India. Irrigation works of India rank amongst the largest in the world. The Sukkur Barrage system in Sind commands an area one and a half times that of Palestine. The Sutlej Valley Project in the Punjab serves an area exceeding the total cultivable acreage in Egypt and the Sudan. The Sarda Canal in the United Provinces commands an area equal to that acreage. The Ganges Canal commands a gross area of  $5\frac{1}{2}$  million acres.

In length of waterways, the Lloyd Barrage system leads with its 6,500 miles of channels. The Cauvery Delta System is 5,400 miles, and four other systems total 3,000 miles each. The Ganges Canal has 4,000 miles of waterways.

India has also many gigantic dams amongst which are mentioned the Lloyd Dam at Bhatgarh, in the Bombay Presidency, the Wilson Dam at Bhandardara also in the Bombay Presidency, the Nizam-Sagar Dam in Hyderabad State which is nearly 3 miles long, and the Mettur and Periyar Dams in Madras.

The total capital outlay on these works up to date is in the neighbourhood of 150 crores of rupees, and the value of the crops raised with the assistance of these works is 100 crores annually. The gross revenue amounts to 13 crores and the working expenses amount to 5 crores. The net revenue is 8 crores of rupees which represents a return of  $5\frac{1}{4}$  per cent. on the capital outlay. The criterion of productive irrigation schemes is that they should ensure a net return of 6 per cent. on the capital outlay, but besides direct return, irrigation schemes are also responsible for an indirect return in the shape of increase in land revenue, railway receipts, postal and custom receipts, etc. The Central Board of Irrigation has launched a survey to estimate the gross value of irrigation schemes in the way of revenue from all sources with a view to obtain capital for new projects on easier terms.

A new development in irrigation in India is the production of power at canal falls and using it on a large scale for irrigation from tube wells. Electricity is being generated at the Mettur Dam and a comprehensive grid system is in operation in the United Provinces. A tube well irrigation system has also been initiated in the United Provinces.

A proposal is also under consideration to set up a Central Research Station under the aegis of the Central Board of Irrigation to deal with the many and varied problems that arise in irrigation engineering.

## MISCELLANEA.

### IRRIGATION PROJECT.

A project estimated to cost about two crores of rupees has been taken in hand by the Baroda State Government. It includes a masonry dam across the river Jhankari.

### POWER PROJECT.

The Mysore Government have accorded sanction to the Shimsha and Jog Hydro-Electric Schemes which are estimated to cost approximately 56 lakhs and 200 lakhs of rupees respectively.

*No. 5—November 1937.*

### TRENDS IN DAM DESIGN—PART II.

Johnstone Taylor.

Various types of arch dams are discussed in this article. Main principles of design are briefly touched upon and some existing dams of this type are described. Construction procedure of one of the dams is briefly described as a typical example.

### THE MARCONAHALLY RESERVOIR PROJECT IN MYSORE.

Dorai Rajan.

Details are given of a proposed reservoir project in Mysore for irrigation storage. The reservoir will be formed by a masonry dam 446 ft. long flank by two earthen embankments 2,508 ft. and 2,310 ft. long across the river Shimsha. There will be one irrigation sluice on the left bank 33 ft. above the river bed capable of discharging 250 cusecs, for irrigating 10,000 acres. The main channel is  $18\frac{5}{8}$  miles long with a bed width of  $18\frac{1}{2}$  ft., depth of water  $4\frac{1}{2}$  ft. and slope of 2 ft. per mile. Brief details are given of calculations for yield from the catchment and capacity of the reservoir, and costs of works.

### SARDA CANAL SCHEME.

A brief note describing important features of the Sarda Canal Project based on a recently published press note. (See page 115 of Bulletin No. 7).

*No. 6—December 1937.*

### STORSTROM BRIDGE.

Describes the important features of this bridge and gives brief details of its construction. (See under "Civil Engineering and Public Works Review" for September 1937 in this Bulletin.)

### A NEW THEODOLITE.

A new and improved type of theodolite of recent manufacture is described, and its special features are mentioned.

## WELDING OF BRIDGES IN INDIA.

Electric arc welding was introduced in the bridge department of the North Western Railway about six years ago. The plants in use and some recent works where welding has been successfully carried out are mentioned.

## BRIDGES.

Features of portal frame bridges, a number of which have recently been built in Oxfordshire, are discussed. The advantages of this type of bridge over the ordinary girder bridges are described.

## TRENDS IN DAM DESIGN—PART III.

Johnstone Taylor.

Earth and rock fill dams are dealt with in this article. Recent practice in earth dam design and construction is described and two recently constructed dams, namely, the Hume Dam in Australia and the Taf Fechan Dam in South Wales are briefly described as typical examples. Rock fill dams are of comparatively recent origin. Features of this type of dam are described with reference to recent structures which include the Treig dam in Scotland and the Shing Mun Dam in China.

## THE STUDENTS SECTION :

### ENGINEERING ESTIMATES, CONTRACTS AND SPECIFICATIONS.

Antia.

Specifications for Cofferdams, well foundations and blasting operations with explosives are given.

## THE INDIAN CONCRETE JOURNAL.

VOL. XI.

*No. 10—October 1937.*

## RECENT DEVELOPMENTS IN PILE FOUNDATIONS.

Upson.

The purpose of this paper is to review and discuss in detail methods and developments in the field of concrete piling for foundations. There are two classes of concrete piles, the precast and the cast-in-situ. In the former the recent developments are few. In the latter there have been improvements and advancement that are significant to the engineer. The cast-in-situ piles are of two types, the shell type and the shell-less type. In Europe and the far east, the precast and shell-less type are favoured. Several types of shell and shell-less concrete piles of recent development are described and the advantages and disadvantages of each are discussed. Results of tests on six types of pile driven on the site of the United States Court House, New York City are given. It is pointed out that the shell type of pile is more favoured by

engineers and consequently much effort and ingenuity has been expended in its development. A recent development is the use of pre-cast concrete piles for providing watertight walls, and a reinforced concrete sheet pile sea wall in Venezuela is described as an example. Several methods and materials have been developed for making the surface of concrete exposed to the action of water waterproof. These include surface coating with asphalt, tar, heavy oil, etc. These methods are briefly outlined. Considerations of load and nature of foundation which should govern driving of piles of different types are discussed.

### THREE SPAN REINFORCED CONCRETE BRIDGE DESIGN IN THE ISLE OF ELY.

Hill.

This article is continued from the previous issue and describes the design of a three span reinforced concrete bridge with cantilevers and suspended slab centre span. Details of calculations for the design of the various members of the structure are given.

### TESTS ON SHRINKAGE OF CONCRETE.

Shank.

\* Portland cement shrinks when it is exposed in relatively dry places.

A shrinkage tendency in combination with some restraining agency such as reinforcing steel develops into a condition of stress. When shrinkage of concrete takes place in reinforced concrete, stresses are set up (tension in the concrete and compression in the steel), which may be mitigated somewhat by the plastic flow of concrete. The plastic flow of concrete is the action of deformation of concrete without the development of proportionate stress under some deforming agency, so far, much of the research work on shrinkage deals with the total amount of shrinkage and not with the rates of shrinkage at various ages. This is important because the strength and plastic properties of concrete vary with age, and rates of shrinkage must vary as well. In this article are presented observations of shrinkage on a few plain concrete and reinforced concrete specimens carried out at the Engineering Experimental Station Ohio State University about 2 years ago. The specimens were made with five different cement water ratios. After 28 days at 70 deg. F. and 100 per cent. humidity the specimens were put into room atmosphere and measurements were taken on them for 500 days. The shrinkage of plain concrete specimens has been shown graphically in millionths of an inch per inch for 500 days. In the case of reinforced concrete specimens, the contraction of the steel was measured by means of the strain gauge. The total shrinkage stress in the reinforced concrete as computed from a formula given by the author is also shown graphically. Results as shown by the curves are interpreted and discussed in some detail.



## TRENDS IN DESIGN AND CONSTRUCTION OF CONCRETE PAVEMENTS.

Gilkey.

Important factors which should be taken into consideration in modern concrete road design are discussed in this article. These include drainage, joints, and control of construction operations. Requirements for a highway for speeds of 60 miles an hour are laid down. Various types of joints, their spacing and dowelling of joints, subgrade treatment, and control of concrete quality are discussed.

*No. 11.—November 1937.*

## DESIGN OF ARCH ROOFS.

Terrington.

The object of this article is to describe the methods of calculating bending moments, thrusts, and shears at any point in the type of arch generally used in roof work and to illustrate their use in practice. It is the first of a series of two articles published in "Concrete and Constructional Engineering", see Quarterly Bulletin No. 7, pages 30 and 32.

## THREE SPAN REINFORCED CONCRETE BRIDGE DESIGN IN THE ISLE OF ELY.

Hill.

This is the final article of a series of three describing the design of various types of reinforced concrete bridges which are being built to replace some old bridges in the Isle of Ely. The two previous articles dealt with the design of a continuous three span type and a suspended slab centre span type with cantilevers. The present article describes the design of a continuous centre span bridge with end cantilevers. The central span is 45 ft. and the end cantilever spans are 16 ft. each. Details and calculations for design are given and the arrangement of the reinforcement is discussed.

## FILLER JOIST FLOOR.

Vasudevan

Filler joist floor is a flat reinforced concrete or reinforced brickwork slab floor in which steel joists or old rails are used as reinforcement instead of the usual steel rods. This article describes the method of design of floors of this type.

## THE CONSTRUCTION OF A SMALL CONCRETE BRIDGE.

This article describes the construction of a small slab bridge such as may be used over narrow streams. No reference is made to the design of the slab and it is assumed that walls are already in existence along the banks of the stream for the slabs to rest upon. The clear span assumed is 8 ft. The preparation of the existing walls, construction of bearing beams resting on these walls to support the slab, shutterings calculating length

of and placing reinforcements, proportioning mixing and placing concrete and other practical details of the work are described. It is recommended that the centering of the slab should be left in position for at least fourteen days and the slab should be covered to keep it moist for at least 7 days.

**POLISHED *in situ* FLOORS, WALLS AND PRECAST CONCRETE.** Burren.  
Describes the process of obtaining an evenly polished surface on concrete floors or walls. The polished surface is more easily cleaned and more hard wearing, and lends itself to artistic treatment with the use of various coloured cements and aggregates.

*No. 12.—December 1937.*

**NOTE ON RECONSTRUCTION OF MILES 20-29, SITAPUR  
BAHRAICH ROAD.** O'Dowd.

Construction operations on the reconstruction work which consisted of laying concrete tracts for heavy bullock cart traffic on one side of the road are described herein.

**THE CHAMBON DAM, FRANCE.** Rich.

This is a concrete gravity dam constructed in France. Details of construction operations are described. Cement was carried to the site of the dam by a cableway  $6\frac{1}{2}$  miles long extending from a railway terminus to the site. The layout of the concrete plant is described. Details of drainage galleries, contraction joints and other accessories are given. The dam is 960 ft. long, 440 ft. high and 230 ft. thick at the base. It will create a reservoir impounding 1,900 million cu. ft. of water.

A Road Design Supplement is included with this issue which gives extracts from a paper by Mr. R. Trevor Jones, Superintending Engineer, Punjab entitled "Some notes on the layout of rural and suburban roads in the Punjab". Illustrations of sections of various roads in India, Germany, Holland, Italy and Belgium are also included.

## INDIAN ENGINEERING.

VOL. II.

*No. 4.—October 1937.*

### NOTES AND COMMENTS.

#### MYSORE ELECTRIFICATION.

An important scheme for the generation of electricity is shortly to be undertaken by the Government of Mysore. The proposal is to construct a dam across the river Shimsa near Sivasamudram where there is a fall of about 600 ft. Another power generation scheme is also under consideration at the famous Jog falls in Mysore.

**MEGHNA BRIDGE.**

A railway bridge is under construction across the river Meghna in Eastern Bengal, on the Assam Bengal Railway. It consists of seven mid-stream spans of 336 ft. and six approach spans of 105 ft. each. The piers are built on well foundations. All the steel work for the bridge has been manufactured in India.

*No. 5—November 1937.*

**EDITORIAL.**

The editor reviews in brief the subjects discussed at the annual meeting of the Central Board of Irrigation held in Delhi in early November.

**NOTES AND COMMENTS.****BIHAR POWER SCHEME.**

It is reported that the question of generating electricity in the Province of Bihar with a view to providing tube-well irrigation in rural areas is being considered by the Finance Minister.

**INDIAN IRRIGATION PROBLEMS.**

Further comments on the annual meeting of the Central Board of Irrigation held in Delhi early in November.

**CURRENT NEWS.****CAWNPORE WATER SUPPLY.**

During recent discussion on the Cawnpore Municipal Board's proposals for the extension of its water-supply scheme, Mr. M. R. Richardson, Chief Engineer of the Irrigation Department agreed to 20 million gallons of water per day being supplied from the Lower Ganges Canal provided the Board increased the carrying capacity of the existing channel.

**CONSIDERATION OF SILT IN THE DESIGN AND MAINTENANCE  
OF OPEN EARTHEN CHANNELS.**

Khanna.

In this article the author discusses the silting of irrigation channels and measures to eliminate conditions which tend to silting up of such channels. The universally accepted conception with regard to silting is that the greater the slope and higher the velocity of flow in any channel the greater must necessarily be the power of transporting heavy particles of silt. This conception is simple and demonstrably true but its application to the solution of silting problems is not so simple. A study of the mean velocity formula for earthen channels shows that if velocity alone were the requisite condition for eliminating silt from channels, the objective could be much better attained by building narrow and deep channels than by making channels with steep slopes. Steep sloped channels have a tendency to

draw into them coarse silt and to widen themselves by cutting the sides, which render them liable to be silted up. The author then discusses the action of recently developed silt excluding devices. These devices prevent the heavily silt laden water nearest the bed from entering the offtaking channel but they have their limitations. If the silting trouble is due to coarse silt, such devices may be successful. But the author maintains that silt troubles are not infrequent on channels in tail reaches where the silt is not coarse. He believes that it is not the heavy grade of silt but conditions favourable to silting which cause silt troubles. In his opinion, elimination of silting troubles may be attained by designing offtaking channels with a free fall at their heads. He discusses how the provision of a large drop into an off taking channel from the parent helps to eliminate silting. Broad crested flumes with clear standing waves are quite as good as free falls.

STUDY OF THE FORMULA  $Q=2.05 LH^{1.5}$

Khushalani-

This empirical formula frequently employed for calculating the waterway required through flumed structures working under drowned conditions is shown by the author to lead to erroneous results when applied to the design of waterway for a regulator. The theoretical formula for a drowned notch with suitable values for the constant term gives more accurate results.

*No. 6.—December 1937.*

#### NOTES AND COMMENTS.

##### BIHAR FLOODS.

The Flood Conference in Bihar which concluded last month passed a resolution to the effect that the damage caused by the floods is usually aggravated by embankment and recommended amendment of the Embankment Act and constitution of a Flood Committee to advise the Government on flood problems.

#### LETTERS TO THE EDITOR.

Mr. Gurwachen Singh in a letter refers to experiments in the U. P. on the reduction of canal losses by the sodium carbonate process and says that the experiments were carried out in limited reaches and actual losses were less than  $\frac{1}{4}$  cusec of water. With the usual method of discharging observations it is difficult to calculate the exact percentage of saving in the canal losses.

#### CONSIDERATION OF SLOPES OF FLOW IN THE DESIGN AND MAINTENANCE OF ARTIFICIAL CHANNELS.

Khanna.

The author states that the consideration of adequate silt transporting slopes should not find any place at all in our code for design of

artificial channels. Silt grades of natural channels adjust themselves according to the slopes of the country through which they pass. Steepest channels have the coarsest silts in them and have the most pronounced silting tendencies. He refers to his book "Theory of flow of water and hydraulics of rivers and canals" wherein the design of a 5,000 cusec channel for Northern India is discussed. Whatever the grade of silt in the parent river, a 5,000 cusec canal off-taking from the river designed to slopes as flat as  $1/12000$  or  $1/16000$  will remain absolutely clear of silt if adequately working head is provided for the canal. The silting up of flat sloped artificial channels in their head reaches in a natural process by which the flow of water and transportation of silt adjust themselves to the natural law. In designing artificial channels therefore we only need to provide for silting up in their head reaches by means of free fall feeding or feeding through broad crested flumes with sufficient drops to ensure a standing wave being maintained despite the silting up of the head reaches. After the question of slope is decided, formulæ or tables are used for fixing bed widths and depths, etc. Chezy's velocity formula with Kutter's co-efficients is perhaps the most accurate but the values of Kutter's co-efficients vary with the index of rugosity in the channels, which is difficult to determine. He recommends the use of a velocity formula, developed by him from data of channels used by Kutter and Ganguillet for working out their famous formula. In conclusion he quotes the example of the Lower Bari Doab Canal main line which "provides a warning against the unwisdom of designing slopes of artificial channels from considerations of size of silt particles in the parent river".

## THE INDIAN JOURNAL OF AGRICULTURAL SCIENCE.

VOL. VII.

*Part V.—October 1937.*

AGRICULTURAL METEOROLOGY ; THE PREDICTION OF THE  
MINIMUM TEMPERATURE ON CLEAR DAYS AT SELECTED  
STATIONS IN INDIA.

Narasimhan.  
Ramdas.

In this paper an attempt has been made to investigate the possibility of predicting by statistical methods the minimum temperature attained by the air at four feet above ground during clear weather from a knowledge of the maximum temperature and vapour pressure recorded on the previous afternoon. In northern India, abnormally low temperatures are usually associated with frost, which is so injurious to crops. By correlating data at 19 stations in India, an equation has been evolved giving the minimum temperature in terms of the maximum temperature and vapour pressure of the previous evening.

THE JOURNAL OF THE INSTITUTION OF ENGINEERS  
(INDIA).

Vol. XVII.

August 1937.

This issue contains the proceedings of the Seventeenth annual general meeting of the Institution held in Bombay in January 1937, the annual report for the year ending 31st August 1936, the presidential address, and addresses of Chairman of local centres. Mr. M. C. Bijawat, Chairman of the United Provinces centre in his address refers to the progress in irrigation during the past eighty years. He draws attention to the losses in transportation and distribution of irrigation water and mentions that only of 40 per cent. of the water actually reaches the field. He refers to the investigations in progress in various Provinces to evolve suitable type of lining so as to reduce this loss. Cultivators also due to ignorance of water requirements of crops fail to utilize usefully the water they receive. In the tube well system where water is sold on a Volumetric basis, one cusec of water irrigates 4 to 5 acres whereas on the canal systems one cusec irrigates about 2 acres. Research on the best means of distribution and assessment has been going on for some time but as yet no successful system has been evolved. These problems require the serious attention of every irrigation engineer.

The following papers are also included in this issue of the journal :—

THEORETICAL INVESTIGATION AS TO THE MOMENTS  
AND SHARES IN A RIGID FRAME CONSISTING OF TWO  
STANCHIONS WITH FIXED FEET AND CONNECTED BY  
A CROSS BEAM.

Sanyal.

This paper gives a method of finding out the horizontal thrust, vertical reaction and moments at the bases of the rigid frame by the principle of least work.

REMODELLING THE CHANNELS AND SLUICES IN THE  
CAUVERY DELTA.

Pillai.

The object of this paper is to describe briefly the field operations and calculations made in the remodelling the channels and sluices of the Cauvery Delta. The Cauvery rises in the Western ghats and flows eastwards into the Bay of Bengal. At the head of the delta the river trifurcates into three branches the Coleroon, the Cauvery and the Vennar. The Coleroon is the main channel of the river and carries the bulk of the floodwaters into the sea. The Cauvery and Vennar

are the principle arteries for the delta irrigation and they divide and subdivide into innumerable branches which form a net work of distributaries all over the delta. Irrigation in the Cauvery delta dates back to very ancient times and there is evidence to show that these distributaries traversing the delta are not natural branches, but properly aligned channels running on the highest levels. Irrigation in the delta is carried out by means of sluices in the distributaries and irrigating channels leading therefrom to the area to be irrigated. The rivers in the delta have silted up progressively and the sluice have very large openings and have also silted up considerably. Other defects in the delta irrigation system include absence of regular supply, disproportionate supply in upper and lower reaches, and occasional floods. Some of the defects will be removed by the operation of the Mettur Dam. Remedies are suggested for silting trouble in the rivers and channels in the delta. The best treatment is considered to be the training of the rivers so that they may flow in uniform channels of curtailed width. The remodelling of the sluices was also necessary in view of their openings being very large in proportion to the area to be irrigated and also because of their having silted up. The principles adopted in remodelling the sluices are set forth and the field work done is described. A duty of 45 was adopted for the remodelling, and the sills of the sluices were raised to conform to the silted bed in front and rear of the sluices. Calculations of vent sizes are given and also a typical example of "Report and Hydraulic Particulars for Remodelling a Sluice." (See Bulletin No. 5, page 12.)

#### THE DESIGN OF MASONRY GRAVITY DAMS.

Williams.

This paper was awarded the Viceroy's prize for the year 1936. In his introductory remarks the author says that the problems of distribution of stresses in masonry dams and their stability have formed the subject of much theoretical and practical research during the last 80 years but no standard profile that has met with general acceptance has hitherto been evolved, and the shapes and proportional dimensions of the many dams that have been erected in all parts of the world have varied considerably. The fundamental principles on which the design of gravity dams should be based are generally agreed upon but it is in the practical application of those principles that opinions have differed. The author believes that it is possible to design standard profiles which, with comparatively slight modifications, could be adopted to any conditions. The object of the paper is to show that such profiles can be devised and to explain the methods by which their proportions can be determined. The author proceeds to discuss mathematically the stresses in masonry dams and

their distribution. He traces the development of theories of stability of masonry dams comprising the work of de Szilly, Delocre, Rankine, Unwin, Levy, and others. Experimental work with models by a number of investigators in the early part of the present century is also briefly described and results of the experiments are reviewed. The general principles regarding the design of masonry gravity dams are then stated and their application to the design of dams are illustrated. A standard design of a triangular dam 300 ft. high is evolved and diagram showing resultants of stresses on such a dam are given. The method of adopting the triangular profile which is a theoretical one to the bulkhead type in which the pointed upper end of the triangular section is replaced by a rectangular crest is explained and a diagram of stresses in a bulkhead type dam is given. Overflow dams in which the top and the downstream face follow the lines of a curve are treated in the same way and the procedure of arriving at the curvatures is explained. Having arrived at the standard profiles, the author gives a table showing the heights and cross sectional areas of twenty dams built in various parts of the world between 1594 and 1934. The cross sectional areas of the standard dams of the same height are also shown in this table, and the percentage by which the area of the actual dam exceeds or falls short of the area of the standard section is worked out. The profiles of these dams are given in a separate plate. The author concludes that the majority of gravity dams hitherto constructed are unnecessarily massive and considers that the triangular profile modified to suit the bulkhead or overflow type as described in this paper can be used for dams up to 300 ft. high provided that correct proportions are maintained and the dams are constructed of first class materials, founded on solid rock, with proper precautions to prevent leakage under the dam and to provide for internal drainage.

#### FLOW OF WATER OVER MASONRY WEIRS AND NOTCHES.

Garga.

This paper describes work in connection with the calibration of certain falls and discharge sites on the Sarda Canal and presents a critical study of the results obtained. The procedure of taking discharge observations and the instruments used are described. Three types of weir falls were calibrated : falls with narrow flat topped weirs ; falls with broad crested weirs ; and weirs with trapezoidal notches. The calibration of each type is dealt with separately. In each case observed discharges over crests are plotted against actual depths of water observed at site and equations to the lines are obtained by applying the method of least squares. The equations are of the exponential type and give the discharge in terms of the length of crest and depth of water in case of narrow and broad crested weirs, and in terms



of the depth of water in case of notched weirs. For narrow flat topped weirs equations have been derived with and without velocity of approach, and the equations are compared to Bazin's equations. Effects of height of crest above bed, of downstream face batter and of the ratio of depth of water over crest to width of crest are discussed, and reference is made to the work of Bazin, Stearn, Merriman and Gibson in this field. Conclusions arrived at from the results of the calibration work are given at the end of the paper. Some of the conclusions are as below :

1. Discharges given by velocity rods are in excess of those obtained by current meters by about 2 per cent.
2. The value of the constant C in the formula for discharge over weirs  $Q=CLH^{3/2}$  is not an absolute constant but varies with H.
3. Discharge is increased by flattening the upstream face batter and also by flattening the downstream face batter up to a certain limit.
4. Discharge is reduced if width of the crest is increased.
5. Discharge over a broad crested weir is given by the formula  $Q=KLG^{1.5}$  where G is the effective depth of water over the crest and the value of K is in the neighbourhood of 3.00. (See also Quarterly Bulletin No. 2, page 42.)

#### METHODS OF ECONOMICAL DECK-SLAB DESIGNS.

Korni

This paper gives a new method for the design of reinforced concrete deck slabs based on a recently developed theory which the author calls the Fopple Marcus Theory. The original theory is due to Dr. Fopple and is too complicated for the average designer but has been simplified to give reasonably accurate results in practice by Dr. Marcus, and has been incorporated in the German Code of Practice. It has been fully dealt with in a paper by Dr. Gehler read before the International Congress for Bridge and Structural Engineering in 1932. The mathematics of the theory is explained and an example of a 20 ft.  $\times$  20 ft. slab supported on all sides is worked out to illustrate the method of slab design according to the new theory. The slab is also designed according to Pigeauds' method which is the conventional method and it is shown that the new method effects an economy of 8% in the concrete as compared to the standard method.

#### COMPRESSIVE STRENGTH OF BRICKWORK, PLAIN AND REINFORCED AND A COMPARATIVE STUDY OF REINFORCED BRICKWORK, REINFORCED BRICKWORK CONCRETE AND REINFORCED CONCRETE.

Datta.

The author has conducted many investigations and experimental researches on reinforced brickwork and reinforced concrete,

extending over many years from 1916 onwards. In this article he gives the results of some of these experiments concerning strength of plain and reinforced brickwork, and comparative strengths of reinforced brickconcrete and reinforced concrete. Results of experiments on the ultimate compressive strength of brickwork in cement carried out by Mr. Burnett, Superintending Engineer, New Delhi in 1916-17 are also presented. An important result obtained is that while crushing strength of plain bricks is about 1525 lbs. per sq. inch, the strength of a pillar made of single brick placed one over the other is 1132 lbs. per sq. inches and the strength of a compound brick pillar consisting of two or more bricks in each layer is only 600 lbs. per sq. inch. The author discusses the cause of decrease in strength of a compound brick pillar and concludes that the weak point in a brickwork pillar is the adhesion between brick and mortar at the joint which brings about its failure earlier than in the case of the bricks. Hoop reinforcement in pillars rectifies this weakness at the brick joints. From the experiments the author deduces the safe stresses for brickwork, reinforced brick slabs and beams, and brick pillars. The comparative strengths of reinforced brickwork, reinforced brick concrete, and reinforced concrete are discussed with reference to deflexion experiments with beams and slabs of these materials. Stresses developed are also worked out and compared. The experiments show that with low percentage of steel there is not much difference between the load bearing capacity of reinforced brickwork, reinforced brick concrete and reinforced concrete slabs and beams. With high percentages of steel, thin R. B. slabs and beams stand very much higher stresses than deep ones. Finally, the author deduces safe stresses for reinforced brickwork slabs and beams.

In the course of the discussion on this paper, the question of corrosion of reinforcements in R. B. slabs and beams with time was raised. The author in reply stated that recent examination of certain works constructed 17 to 19 years ago shows no evidence of corrosion of reinforcement. He also refers to regulations proposed by him for carrying out reinforced brickwork, and reinforced concrete works which ensures immunity from any corrosive action.

## THE MADRAS ENGINEERING COLLEGE MAGAZINE.

VOL. VI.

*No. 1.—November 1937.*

### SOME POINTS IN THE DESIGN OF REINFORCED CONCRETE WORKS.

Berry.

This article deals with general principles of design of ordinary reinforced concrete work carried out by local authorities. Theoretical requirements are discussed in co-ordination with practical

experience, and recommendations are given with regard to safe working stresses, the placing of reinforcement, cover to rods, and the design of stirrups. The design of simple individual members such as footings, columns, beams, slabs, and small water tanks, is treated in outline.

## SCIENCE AND CULTURE.

VOL. 3.

*No. 4—October 1937.*

### MOSCOW—A SEA PORT.

Cotte.

A general account is given of the Moscow-Volga Canal which has recently been completed. The reasons for constructing the canal, the benefits to be derived from it and the main features of the work are described. (See page 35 of Bulletin No. 6.)

*No. 5—November 1937.*

### ANNUAL REPORT OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH, 1936-37.

Editorial review of the report giving brief details of schemes financed by the Council and other activities mentioned in the report. (See page 115 of Quarterly Bulletin No. 7.)

### NOTES AND NEWS.

#### AGRICULTURAL RESEARCH IN INDIA.

Recommendations and suggestions made by Sir John Russell in his report on the the working of the Imperial Council of Agricultural Research are briefly summarized.

#### SILVER JUBILEE MEETING OF THE INDIAN SCIENCE CONGRESS.

The tour programme of the delegates is given and papers of special interest which are being presented in the different sections are mentioned. List of foreign delegates is also given.

### SCIENCE IN INDUSTRY.

#### STORES DEPARTMENT AND INDIAN INDUSTRIES.

The annual administration report of the Indian Stores Department for 1936-37 is reviewed herein. The inspection branch was entrusted with the inspection of the steelwork of the Meghna Bridge, and the first instalment of material manufactured by Tata Iron and Steel Co., for the new Howrah Bridge. Investigations and researches included tests on clay for Quetta buildings and on cements for the new Howrah Bridge.

*No. 6—December 1937.*

**GOVERNMENT SCIENTIFIC DEPARTMENTS AND  
LEARNED SOCIETIES.**

Fifty years ago modern research was unknown in India. With the spread of Western ideas during the last fifty years a number of Societies and Government research departments have come into being. Short accounts of the more important learned Societies and Government research departments now existing are given herein. The following amongst others are mentioned.

1. Geological Survey of India. The main duty of the Geological Survey of India is the investigation of mineral resources of India, but it is consulted by Central and Local Governments on engineering questions such as preventing landslips, suitable sites for dams and canals with respect to geological structure of the strata, prospects of obtaining underground water, suitability of rocks for buildings and road work, and the construction of earthquake resistant buildings.
2. Indian Meteorological Department. This department supplies forecasts for rainfall and prepares rainfall data for the whole of India.
3. The Survey of India. This department carries out topographical surveys and prepares maps for the whole of India. River and irrigation surveys are undertaken on payment by those concerned and aerial survey work for civil and military purposes is also undertaken.
4. The Institution of Engineers, India.
5. Indian Society of Soil Science. This Society was established in 1935 at Calcutta to cultivate and promote soil science in association with the International Society of Soil Science.

**THE FARMER'S WEEKLY.**

**VOL. XLVIII.**

*No. 1338—February 6th, 1935.*

**SAVING ON THE IRRIGATION BILL.**

**Pels.**

This article gives a general description of researches in California on plant, soil and moisture relationships. The investigations were directed to the study of the behaviour of water in the soil. It was discovered from these investigations that there is a fixed amount of moisture which a given type of soil would hold under any circumstances. The water is held between the soil particles. Investigations on the rate of consumption of water by plants were also made and it was found that the rate of consumption of water bore no relation to the quantity available but was the

same whether the moisture content of the soil was high or low. It was also found that a soil would hold a certain percentage of moisture which it would not give up to the plant. This percentage is called the wilting percentage and the amount of moisture over and above the wilting percentage is the readily available moisture. The theory that there is considerable capillary movement through the soil and that as fast as water evaporated from the surface new moisture rose from below to take its place until the entire subsoil was dried out has also been exploded as a result of investigations.

These investigations are likely to throw a new light on the practice of irrigation and will prevent the wasteful practice of over irrigation and other practices based on ideas which have been proved to be wrong by the investigations described.

## REVISTA DE LA SOCIEDAD CUBANA DE INGENIEROS.

(In Spanish.)

VOL. XXX.

*No. 9—September 1937.*

*No. 10—October 1937.*

Nothing of interest to irrigation engineers in these issues.

## CIVIL ENGINEERING (NEW YORK).

VOL. 7.

*No. 9—September 1937.*

### CLOSING THE FORT PECK DAM.

Larkin.

“Every large undertaking involves some particularly delicate and crucial operation that may spell success or delay, possibly failure. In the case of the Fort Peck Dam this important feature was the closure of the main dam throwing the river flow through the mammoth diversion tunnels . . . . . Even with the complete preparations for closure so well described in this article, fate intervened in the form of an unexpected slide threatening a vital railroad artery. By shifting the point of attack to the downstream instead of the upstream toe the closure was successfully effected”. This article describes the preliminary operations carried out for the closure, the unexpected slide which upset the plans for closure as laid out and the emergency operations by means of which the closure was effected successfully. (See also Bulletin No. 7, page 95.)

**THE MORTIMER E. COLLEY BRIDGE.****Millard.**

This steel structure consists of a 300 feet main span formed by two 125 feet deck truss cantilever arms resting on concrete piers and supporting a 50 feet suspended section, and two anchor arm spans at either end of the main span the ends of which are tied down to concrete abutments. This bridge was awarded the first prize by the American Institute of Steel Construction as the finest bridge of its class built in the United States in 1935. It carries a 30 feet wide roadway. The piers are simple pedestals of concrete resting on clay and the abutments are each constructed with six reinforced concrete columns resting on spread footings. Details of design and construction of this bridge are described.

**ENGINEERS' NOTEBOOK.****FLOW ON STEEP SLOPES.****Hedberg.**

The writer emphasizes the fact that flow on steep slopes is distinctly a different problem from that of flat grades. All our hydraulic theory on flow in open channels carries the proviso that flat slopes are assumed. Yet some of the most troublesome problems are encountered in chutes on grades of 10 to 30 per cent. In solving problems of steep flow either it has to be assumed that the theory for flat slopes is sufficiently exact for practical purposes or models have to be built to demonstrate the best design. Observations of flow on steep grades show that in many cases neither of these procedures is reliable. A brief discussion of the forces at work in flow on steep slopes is given and it is shown that the error resulting from the neglect of the slope factor in the velocity and pressure heads is considerable. Model tests are considered unreliable because of the impossibility of simulating the phenomena of the entrainment of air. Quantitative results must therefore not be expected from spillway model tests and only qualitative results are possible.

**OUR READERS SAY.****ASPECTS OF FLOOD CONTROL.**

Comments on the article "Economic Justification for Flood Protection" published in the May 1937 issue of this journal (see Bulletin No. 6, page 81), are made in two letters. The evaluation of flood losses as a basis for determining the amount to be spent for flood control, and of benefits of flood control measures are further discussed in these letters.

**CURRENT PERIODICAL LITERATURE.**

*Am. Conc. Inst. J. Vol. 8, No. 3, Jan.-Feb. 1937.*—"Earthquake Resistance and reinforced concrete" by Creskoff, gives principles of aseismic design in reinforced concrete.

*Izvestiya Nauchno-Issledovatel'skovo Instituta Hydrotechniki*, No. 19, 1936. Main results of soil consolidation research at Moscow are given. Experimental studies on waterproofing of canal linings with bitumen sand mixes, silicate water glass compound, etc., are described.

No. 10—October 1937.

#### COMPENSATORY WORKS FOR ST. CLAIR RIVER.

Pettis.  
Moore.

"For a considerable number of years the levels of lakes Michigan and Huron have been progressively lowered by diversions of water and by enlargement of the channels connecting lake Huron with lake Erie . . . . . To restore the former levels, it is proposed to construct a series of submerged sills in the St. Clair River, the outlet of lake Huron . . . . . Detailed analyses and model studies of the project have been made. Some of the economic and hydraulic factors involved are reviewed in the present article".

To decide upon the most efficient type of sill, experiments were carried out first in a small flume in the hydraulic laboratory of the University of Michigan. Further detailed experiments were made at the U. S. Waterways experiment station at Vicksburg, and the results indicated that sills with vertical upstream faces would secure the maximum efficiency and produced the greatest backwater effect. A model of the upper St. Clair River was built to a horizontal scale of 1 : 100 and a vertical scale of 1 : 30. The model was 180 feet long and the minimum river width was 8 feet. Preliminary tests, however, showed that to reproduce the natural profile, a larger flow was required than that indicated by the similitude relationship. The experiments were made with a larger flow than was theoretically correct and another model was built true to scale, in which the volume of flow and the profile were adjusted satisfactorily to the true similitude relationship. Results obtained from the two models were in agreement and indicated that eight sills with vertical upstream faces would produce the backwater rise required. All the types of sill which were tested are illustrated. (See also page 95 of Bulletin No. 4.)

#### SHEAR DEFORMATION INCLUDED IN THREE-MOMENT EQUATION.

Floris.

Lateral earthquake forces can best be transferred to the foundation by means of floor slabs. These concrete slabs are usually continuous over several walls and can therefore be analyzed by the three-moment equation. In its standard form, this equation does not include the influence of shearing forces on the moments over the supports. In a slab subjected to horizontal

loads the effect of the shearing forces is appreciable. The purpose of this article is to derive a three-moment equation in which the shearing deformation is included. This equation can be applied in the same way as the standard three-moment equation and actually the introduction of the shear term facilitates the solution. The author derives the equation and demonstrates its application to a typical problem.

#### OUR READERS SAY.

##### STEREOSCOPIC MAPPING IN BRAZOS RIVER REGION.

Some further information is presented in this letter in connection with the article on "Air-Mapping the Brazos River Area" published in the July issue of this journal. (See Bulletin No. 7, page 77).

##### OUTSTANDING FEATURES OF NEW BUILDING CODE FOR NEW YORK.

A summary of the principal features of the new code is given in this article.

##### CURRENT PERIODICAL LITERATURE.

*Am. Conc. Inst. J.*, Vol. 8, Nos. 3 and 5.—"Study of Subaqueous Concrete" by Anderson. Comparative observations on behaviour of concrete deposited under water are given. Effect of grading of aggregates and fineness of cement on compressive strength is discussed and the best mixture for subaqueous concrete is given.

*Am. Conc. Inst. J.*, Vol. 8, Nos. 3 and 5.—"Portland-Puzzolan Cement as used in Bonneville Spillway Dam" by Clark and Brown. Gives the following information about Bonneville Spillway Dam: general description, location and foundation conditions, design of dam, cement investigation and selection, special cement specifications, final concrete studies, stress analyses, and construction experience.

*Am. Conc. Inst. J.*, Vol. 8, No. 3.—"Concrete Rehabilitation Work on Uncompahgre Project" by Reeves. Describes condition of 4 miles of concrete lined section of a canal after 30 years of operation, repairing of lining with gunite and construction of new canal lining.

No. 11—November 1937.

##### SOME ENGINEERING BEGINNINGS.

Kirby.

"Although there is basis for the recent claim that engineering did not find a place among the learned professions much before the middle of the eighteenth century, its beginnings go back at least as far as 3000 B. C. Starting in Egypt and Mesopotamia



the centre of construction activity later shifted to Rome and its provinces. By the beginning of the Christian era, China's Great Wall, Grand Canal, and certain irrigation systems had already taken form. Construction of bridges and roads continued in China and in the New World came to a climax with the Incas about 1300 A. D. while Western Europe was still in the dark ages. Few records of these early Asiatic and American achievements exist..... In the accompanying article Professor Kirby sketches high lights in the story of engineering up to about the year 1750".

#### **FLOOD CONTROL IN NEW ENGLAND.**

The New England floods of March 1936 focussed attention upon the urgent need for flood protection in that area. The result of studies made by both the Water Resources Committee and the U. S. Engineer Corps were described in three papers delivered before a meeting of the North Eastern Section of the Society held in Boston in May 1937. Abstracts of these papers are presented.

#### **WATER RESOURCES COMMITTEE RECOMMENDATIONS FOR NEW ENGLAND.**

Barrows.

This is the first of the three articles and outlines the recommendations of the Water Resources Committee as a whole. The most important aspects of the flood control question in the New England States are the flood control plans for the Connecticut and Merrimack river basins. The Committee's recommendations suggest a group of 37 reservoirs with a total storage capacity of 49 billion cubic feet in the Connecticut basin. The reservoir system is intended to serve the needs of flood control and power generation. For the Merrimack basin 9 reservoirs with a total capacity of 27 billions c. ft. are suggested for flood control and power purposes. The plans of the U. S. Engineer Corps recommend 20 reservoir projects for the Connecticut basin and 5 reservoirs for the Merrimack basin. One third of these are to be of the retarding basin type with outlet conduits and no gates. In addition to these reservoirs, local flood protection by dikes is proposed for important cities in the lower reaches of the rivers. The plans of the U. S. Corps of Engineers however are mainly directed to flood control without taking into account other important water uses such as power and provision for a well regulated increased low-water flow. These aspects are cared for in the plans of the Water Resources Committee.

#### **ARMY ENGINEERS' PLAN FOR CONNECTICUT VALLEY.**

Young.

This article describes in some detail the plan of the U. S. Engineer Corps for flood control in Connecticut basin by 20 reservoirs and 7 dykes. Data for the proposed works with probable costs

are tabulated, and the computation of direct and indirect losses and benefits are discussed. An instructive comparison is also made of the proposed plan with the Miami Flood Control Project.

**ARMY ENGINEERS' PLAN FOR MERRIMACK VALLEY  
AND PRINCIPAL MAINE RIVERS.**

Casey.

This article describes the U. S. Corps of Engineers plan of flood protection in the Merrimack basin, which consists of five proposed reservoirs with supplementary river walls and channel improvements. The procedure of flood control surveys in the river basin is briefly described. In connection with selecting the most appropriate method of flood control, the author discusses the use of reforestation, reservoirs, channel improvements, diversions, and levees in flood control. He is of opinion that reforestation measures will not be of material value for flood control in the area in question, and the most desirable method is that by reservoirs, but tremendous storage capacities are necessary. Levees and channel improvement serve their best use as supplementary measures of flood control. Summarizing his conclusion the author states that the best solution for the control of floods in any large river basin will combine a moderate degree of reservoir control with levees in areas where flood damage is concentrated, and with a limited amount of channel improvement at critical places. He then discusses results of investigations in the Merrimack basin and mentions emergency relief work which is being carried out.

**THE MANUFACTURE OF STRUCTURAL CLAY PRODUCTS.**

Emery.

Describes the process of manufacturing glazed and unglazed tile and architectural terra cotta from the pit to the finished product.

**GEOLOGY AND CIVIL ENGINEERING.**

Hotchkiss.

The importance of the science of geology to the civil engineer in dealing with foundation problems is discussed in this article. Important characteristics of some rocks and their origin are reviewed, and difficulties in studying foundation conditions with laboratory examination of samples are discussed. The need for a method of making tests on rocks without removing samples is emphasized.

**ENGINEERS' NOTEBOOK.**

**USE OF REINFORCED BRICKWORK IN LINCOLN  
TUNNEL BUILDINGS.**

Dunham.

The walls of the ventilation building of the Lincoln Tunnel are being constructed of brickwork reinforced with steel rods. Details of the work and the circumstances which necessitated the use of this form of construction are described.

# FORECASTING RAINFALL BY MEAN SEASONAL DISTRIBUTION.

Wenderoth.

A method is described of forecasting rainfall from rainfall data of a station covering a period of years. The use of the method is illustrated by an example.

## ENGINEERING AND CONTRACT RECORD.

VOL. 50.

*No. 55—January 13, 1937.*

### FLOOD CONTROL MEASURES ON THE GRAND RIVER.

Adams.

The Grand River Valley in south western Ontario is the most thickly populated area in the Province. The river and its tributaries drain an area of highly productive agricultural lands which have been improved by drainage. With the cutting down of forests and draining of swamps, which provided summer storage, the intensity of floods has increased tremendously in recent years. To remedy these conditions it is proposed to construct four impounding reservoirs on the river and its tributaries each with a storage capacity of 10,000 acre feet, and a low dam at the outlet of the river from Luther Marsh. The reservoirs would be formed by dams across the river valley approximately 50 feet high. The locations of the reservoirs, the anticipated reduction of flood levels, the minimum stream flow, and the estimated capital costs are given in tabular form. Nature of the drainage area, and investigations in connection with the proposed project are described, and the bearing of the proposed project on water supply and sewage problems of the drainage area of the river is discussed.

## ENGINEERING NEWS-RECORD.

VOL. 119.

*No. 10 —September 2, 1937.*

### CONCRETE PONTOON BRIDGE PLANNED.

A concrete pontoon bridge across lake Washington is being planned and if the plans are adopted, the bridge will be the only one of its type in the world. It will be 8,000 ft. long and will consist of a series of concrete pontoons connected together and anchored to a sunken island at a point where the water is 36 ft. deep.

## COMMENT AND DISCUSSION.

## BEAM DEFLECTION.

Mr. Troelsch gives a method of determining deflections of a continuous beam. He considers that once the bending moments are known, the deflection of any span of a continuous beam can be obtained by treating the span as a simple span subjected to the continuous beam moments.

## EARTH CORE CHEAPENS ROCK BREAKWATER.

Gilland.

A detached breakwater now being constructed as a protection for Los Angeles and Long Beach outer harbours consists of an earth core enveloped by a rock fill. Cross sections of the breakwater are given. Originally the breakwater was to be a rockfill structure but material dredged from the harbour to enlarge it was available for the fill and was used with successful results. The equipment and methods of placing the fill are described and the economy of this composite type of construction is discussed.

## OVERSEAS ROAD TO KEY WEST.

Chamberlin.

Over thirty miles of the railway spanning the Florida Bay are being converted into a modern paved highway. The railway was seriously damaged by a storm in 1935 and the Railway Company was unable to finance the rebuilding of it. It was therefore decided to convert the railway into a highway. About 13 miles of bridge structures are included in the project. The longest bridge is about 7 miles, and consists for the most part of heavy 80 ft. steel girders on concrete piers, but there is a length of about 9,000 ft. of plain concrete 35 ft. span arches. The increased width for the roadway has been provided by welding 25 ft. long steel beams 10 ft. apart, crosswise on the main girders of the old bridges. In the case of the arch spans, the cross beams are set in slots cut in the old concrete arches.

*No. 11—September 9, 1937.*

## UNUSUAL FOUNDATION PLANT FOR LONG BRIDGE.

The Neches River bridge which is being built in Texas is one of the largest in Southern U. S. A. The river is only 1,000 ft. wide at the site but it traverses a wide expanse of salt marsh over which the approaches lie, and the total length of the bridge is 7,700 ft. It consists of a 680 ft. cantilever centre span flanked by 374 ft. through-truss anchor spans and deck trusses. The approach spans are shorter and are of the deck girder and concrete slab type. The marsh land on either side of the main stream is incapable of supporting even the construction equipment. Road building across the swamp for carrying the construction equipment was out of the question on account of excessive cost. A

channel was therefore dredged through the marsh along the line of approach piers, to provide for floating equipment. In this article the foundation operations are described. The main spans are carried by eight pairs of circular caissons 18 ft. to 32 ft. in diameter sunk about 100 ft. through the mud to hard clay. The approach spans are supported by low concrete piers resting on untreated wooded piles from 70 to 86 ft. long driven on a batter. An ingenious driving rig developed by the contractor for pile driving is described. The caissons are of heavily reinforced concrete, the walls being 4 ft. to 5 ft. thick and they were driven by the sand island method (see page 36 of Bulletin No. 6), and were sunk by open dredging.

#### EVAPORATION LOSS IN COVERED RESERVOIRS.

Young.

Investigation of evaporation losses from a covered reservoir were carried out at La Verne, California. The results are discussed and the conclusion arrived at is that some conservation of water is effected by a reservoir cover although not in sufficient quantity if its value be capitalized to pay for the cost of roofing.

#### DRILLED PILES SEATED IN ROCK SOCKETS.

Foundation work recently completed on a Sanitation Department garage building in New York is described in this article. A feature of the work is the use of large capacity concrete filled steel pipe piles of unusual design. These pipe piles enclose steel columns which are extensions of the building columns of the superstructure. The pipe piles are sunk by drilling through the top soil on to the bed rock. They extend only a short distance into the bed rock. An oversize hole is drilled into the bed rock from the bottom of the pipe piles to form a socket into which the steel columns passing through the pipe piles are extended. This socket is filled with grout and the pipe pile is filled with concrete up to the top. The necessary length of this socket is determined from consideration of bond stress necessary to carry the load not accounted for by direct bearing. The unique characteristic of these "foundation columns" as they are called, is that a considerable portion of the load is delivered to bed rock not by direct bearing on its surface but by bond in the rock which is developed in the rock socket below the pipe pile.

The load capacity of a "foundation column" and the value of the bond developed in the rock socket were determined by means of a special test set-up. The tests and the set-up used are described.

#### ROAD SOIL BASE BOUND WITH CEMENT.

Allen.

A cement stabilized soil base 1 ft. thick was constructed in Kansas U. S. A., in 1936 under a concrete pavement. The soil was silty

and very unstable when wet. The construction procedure on this work is described in this article. Briefly, the procedure consisted of spreading cement on the top of the pulverized soil of the road bed at the rate of 5 lb. per square yard per inch of compacted depth and thorough mixing of the cement and the soil; addition of water to the dry mix; and rolling with a sheep's foot roller. Details of the procedure adopted with practical observations on difficulties encountered and improvements needed are given.

#### BASE PLATE DESIGN FOR BEAM TAKEN ACCOUNT OF DEFLECTION.

Lothers.

In designing base plates to distribute the load from the end of a beam to its masonry support it is customary to consider the load as uniformly distributed over the masonry. The author considers that this assumption is not correct and actual conditions obtained in practice show that the load is not uniformly distributed. He analyses the case of a simply supported uniformly loaded steel beam resting on top of a column having a cross-sectional area equal to that of the base plate and develops a number of equations for the design of the base plate based on his new conception of unequal distribution of load on the column. An example is worked out illustrating the method of design. Lines along which cases with conditions of loading and support can be treated are indicated.

#### ABUTMENT SETTLEMENT STUDIED BY SOIL MECHANICS.

Grover.

That the principles of soil mechanics can be successfully applied to predict accurately the bearing power of a soil under a superimposed load, has been shown during the course of certain investigations carried out in connection with the settlement of a bridge abutment in Kansas. A study of the subsoil conditions and examination of the soil indicated that the settlement was due to compaction of a 12 ft. stratum of soil with 36 per cent. average moisture content while the liquid limit of this soil was found to be only 33 per cent. The investigations are briefly described and the results are discussed.

#### NEW USES FOR COTTON TO BE STUDIED.

The Agricultural Adjustment Administration has arranged to provide cotton fabric to various agencies for experimental purposes along certain specified lines. The experiments will include the use of the fabric in the reinforcement of asphalt lined irrigation ditches, stabilizing raw cuts and fills along highways, levees, revetments, and earth dams, the prevention of soil erosion, and reinforcement for road surfaces.

*No. 12—September 16, 1937.*

## **THE WEEK'S EVENTS.**

### **WHEELER DAM.**

Wheeler Dam, the second of the Tennessee Valley Authority's dams to be completed and placed in service was formally dedicated on September 10, 1937. It impounds a reservoir which carries navigation 74 miles upstream of it to the third dam which is now under construction.

## **COMMENT AND DISCUSSION.**

The Chief Engineer, Pennsylvania Department of Highways gives a full account of the expansion joint failures and repairs on the Westinghouse Bridge at Pittsburgh (See page 101 of Bulletin No. 7). Details of the joints showing existing conditions which resulted in cracking and the proposed method of repair are illustrated.

### **EXPERIENCE WITH WELLS IN FINE SAND.**

Archer.

Ten years' experience with the well system of Amarillo, Texas shows that the problem of obtaining a continuous supply of water from fine sand and silt formations has been solved successfully. In these wells open screens are used through which the fine sand is drawn and ejected. The sand drawn out is gradually replaced by gravel introduced at the top of the casing. The details of construction of these wells are given. A study of the conditions of the installation after 10 years' operation reveals that the capacity of the wells has increased tremendously.

### **CONCRETE WALLS AS COUNTERWEIGHTS.**

A unique expedient has been employed to counterbalance the dead loads of the steel arch roofs of two aeroplane hangars built in San Francisco. Two reinforced concrete walls are hung from the two ends of the arch steelwork to act as counterweights. The steel superstructure of the hangars consists essentially of arched trusses with a span of 217 ft. The outer side walls are suspended from a portion of each arched truss extended for this purpose outside the arch supports. By this means, most of the dead load on the trusses was counterbalanced, the stresses in the centre portion of the arches were decreased, and considerable economy in construction costs was effected. Details of the construction are described.

### **EARTH SHOCKS AT BOULDER DAM.**

The revised report of earthquake observations at Boulder Dam shows a total of 13 shocks in the month of June of which one was of intensity V. In some quarters it is apprehended that

there might be important displacements in the vicinity of the dam but according to the Director of Coast and Geodetic Survey, earthquakes that do not exceed intensity V are not accompanied by earth movements that can be measured. Comparison of lake level fluctuations with the record of shocks does not indicate that a stationary lake level means an absence of earthquakes. A naturalist sometime ago mentioned indications of the existence of a natural lake on the site of Lake Mead in comparatively recent geological times. This suggests that the area may now be readjusting itself to a condition of loading that obtained previously.

#### NON-SHRINKING MORTAR.

A liquid with the trade name of "mortite" has been manufactured which when added in small quantities to brick mortar makes it very workable and permits of a smaller quantity of water being used for the mortar, thus reducing shrinkage. Mortar made with "mortite" does not develop shrinkage cracks and does not separate from the bricks.

*No. 13—September 23, 1937.*

#### THE WEEK'S EVENTS.

##### WPA DAM FAILS AT KANSAS CITY.

An earthfill dam near Kansas city failed by settlement of the downstream side along half its length. The dam was planned to be 84 ft. high and 1,550 ft. long and was nearing completion when the failure occurred. It has a puddle clay core and was constructed of clay placed in 8 inch layers and compacted with sheep's foot rollers. The dam is 550 ft. wide at the base and was about 50 ft. wide at the 80 ft. level to which it had been built. Foundation failure is believed to be responsible for the failure. The foundation material is soft blue shale or clay. Preliminary borings indicated the material to be hard and impervious shale but later on it was found to be much softer than anticipated. A sheetpile cut-off was driven to rock, 50 to 90 ft. below ground level.

##### WELDING FOR NEW YORK BUILDINGS.

Fish.

The new building code for New York city which is to take effect from January 1938 makes full provision for welding structural steel. During the last eleven years several hundred other American cities and towns have given legal recognition to welding. The advantages of welding over rivetting are discussed and the safety and economy of welded construction are emphasized.



*No. 14—September 30, 1937.*

## THE WEEK'S EVENTS.

### FOUNDATION OF EARTH DAM FAILS.

A further detailed report of the failure of Marshall Creek Dam in Kansas is given herein. The cause of the settlement of about 700 ft. length of the dam on the downstream side is attributed to the failure of the foundation material to support the weight placed upon it. This portion of the embankment settled 40 to 50 ft. and moved downstream nearly 60 ft. leaving an almost vertical face. A detailed cross section of the dam is given and the method of construction is described. Details of foundation conditions of the site are given and the foundation explorations before the construction are described. The top layer of the sub-soil for about half the width of the valey consisted of loess underlying which there was a layer of blue clay 20 ft. to 30 ft. deep. In preparing the site all surface loam down to the loess was removed. Inspection of the dam after the failure indicated that compaction of the clay was perfect. The slide is under investigation by a board of survey.

### SEEPAGE FROM RESERVOIR TRACED TO EARTHQUAKE.

Complaints made by resident in the neighbourhood of San Pedro Concrete reservoir in Los Angeles that water was seeping into their basements led to the discovery of a crack in the bottom extending the full length of the reservoir. Test holes drilled round the reservoir showed that the ground was saturated with water. The engineers concluded that the crack was caused by the 1933 earthquake. The bottom contained many small cracks as the concrete was not reinforced. The major crack and all other serious cracks were cut out and filled with concrete. The bottom was then paved with 2 inches of flexible asphalt concrete. Tests after refilling showed only a small amount of leakage.

### GROUNDWATER SUPPLIES MENACED IN NEW JERSEY.

Groundwater supplies for the large industrial developments in an area in New Jersey are being depleted rapidly on account of increasing pumpage from the wells. When wells were first driven into the sand bed, which is the source of supply, the water rose 35 to 40 ft. above sea level while in 1935 the water level in some of the wells was as much as 73 ft. below sea level. A report dealing with the investigations has recently been issued by the New Jersey State Water Policy Commission.

### BOOK NOTES.

"Applied Fluid Mechanics", by O'Brien and Hickox, 360 pp. \$3.50.  
This book discusses recent developments in fluid flow knowledge

and illustrates the application of the principles of these recent developments to practical problems. Turbulence, surging, cavitation, and other flow phenomena are described in general terms. A complete elementary derivation of the equations describing the motion of a frictionless fluid is given. Practical applications of fluid mechanics principles to weir, orifice, gate, pipeline, meter, and open channels problems are discussed at length and cover more than half the book. An unusual feature is a chapter devoted to the principles involved in studying open channel flow by geometrically similar and distorted models.

*No. 15—October 7, 1937.*

### **NO MORE FLOODS FOR FITCHBURG.**

Fitchburg is an industrial city in Massachusetts and is situated on the North Nashua River which winds through the city. With the development of industries several dams were built on the river for power purposes most of which were abandoned later and fell into disrepair. Plants and buildings encroached on the normal stream channel, and the river became a dumping ground with the result that the waterway was almost completely obstructed in places. The city was seriously flooded in 1936 and a flood control project was taken in hand by the Army Engineers. The basis of design was to provide a channel 80 ft. wide at the bottom with walls or banks at least 13 ft. high. The river improvement programme which is in progress now comprises channel improvements, bank protection, and grading of the river bed on a reach of five miles on the river. Details of the works are described in this article and typical methods and conditions are illustrated. Construction operations are described in detail.

### **CREST LENGTHS CLASSIFY DISCHARGE.**

Abbett.

Some interesting results derived from the study of a number of experiments on flow over unsubmerged weirs of different crest lengths are discussed in this article. In making this study eleven sharp-edged rectangular weirs were used; crest lengths varied from  $\frac{1}{2}$  in. to 48 inches and heads ranged from zero to 1 ft. The results of experiments on each weir were expressed by a formula of the type  $Q=KLH^n$  and the discharge co-efficient  $K$  and the exponent  $n$  for each of the eleven weirs were plotted against the crest length. The graphs so obtained indicate that crest lengths between  $\frac{1}{2}$  in. and 2 inches have a constant value of 1.5 for the exponent  $n$  while crest lengths greater than 8 inches have a somewhat lower constant value of 1.465. Separating these two "Constant value" zones is a transition zone in which the value of the exponent varies from 1.465 to 1.5. A universal weir formula is therefore impossible. It is seen therefore that any attempt to derive an empirical formula for a weir

with a constant discharge co-efficient will be restricted to one specific crest length and such a formula applied by direct proportionality to any other length will result in error.

#### STEEL STRESSES IN CONCRETE PIPE.

Gumensky.  
Whitman.

A series of tests made recently on large reinforced concrete pipes in which the actual strains in the reinforcing steel were measured while the pipe was subjected to combined internal and external loads is described in this article. Many types of specially constructed test pipes 60 inches in diameter were used for the tests. They were constructed and reinforced in different ways. Details of reinforcement in each type are given. The pipe sections were tested in a machine with a pressure capacity of 135,000lbs. Strains in reinforcing steel were measured by a strain gauge. A comparison is made of observed and theoretically computed stresses, and most of the observed stresses are found to be less than computed values. In conclusion the authors give their findings on the design, reinforcements and behaviour of pipes as deduced from analyzing the data collected in this investigation.

#### WATERWORKS MEN MEET IN MAINE.

The fiftysixth annual convention of the New England Water Works Association was held in September last at Poland Spring Spa. The technical programme consisted of a symposium on pipe corrosion problems and another on gravel packed wells, papers on treatment technique, watershed protection and spillway model tests. The papers on gravel packed wells dealt with recent installations and operating experiences with such wells in Massachusetts. The importance of thorough tests to insure proper selection of well sites was stressed in connection with a gravel packed well where careful study of draw down curves under various rates of pumping established the limits of the selected area to within a 100 ft. square. Another paper describes how the substitution of a high velocity tube well by a low velocity gravel packed well solved the problem of reducing the iron content of the water to a considerable extent. The paper on spillway model tests gives details of model experiments carried out in connection with the design of the spillway for the Bills Brook Dam of the Metropolitan District of Hartford county.

#### TOLERANCES AND REINFORCING FOR TITLED CYLINDRICAL PIERS.

Chambers.

From experience in three recent cases of deep cylindrical pier foundation construction in New York City, the writer proposes a method of reinforcing deep cylindrical caissons which provides for both compression and tension. His contention is that both excessive compression and tension are present in an eccentric pier and both must be provided for.

**CARRIAGE FOR SLOPES.**

Stillman.

Describes a moving platform being used for guniting the soft sand slopes of a reservoir embankment for the Rome, N. Y. water supply. The men work on the platform thus preventing the fine graded earth slope from being trampled. The platform consists of four 12 in.  $\times$  12 in. timbers, 50 ft. long, placed parallel to the embankment slope and supported by two cross beams at the top and bottom of the slope. The cross beams are carried by 18 inch wheels which move along the length of the embankment.

*No. 16—October 14, 1937.***NEWS OF THE WEEK.**

The work of refacing Arrowrock Dam in Idaho is now being carried out by the Bureau of Reclamation. Concrete deterioration on the face of the dam necessitated chipping off a layer and providing a new slab.

**THE MOIST CURING OF CONCRETE.**

Gilkey.

In this article results are presented of an extensive series of tests at Iowa State College on curing carried out with concretes and mortars of many aggregates and gradings from several cements and for test ages up to a maximum of 4 years. In discussing the results the author draws attention to the very great range of strengths that can be developed by specimens cast from a single batch but cured differently or in different moisture states at test. By curing and test condition alone the one year compressive strength may often be made to vary between 45 and 135 per cent of the standard cured 1 year strength. Curing diagrams are given showing ultimate compressive strengths against age, for specimens subjected to different curing processes. An important observation is that specimens tested dry are 30 per cent stronger than wet tested specimens which is an advantage on the side of safety since design strengths are usually based on wet tested values.

**COMPARISON OF RUBY DAM DESIGNS.**

Jorgensen.

The Ruby Dam is a constant angle arch dam of concrete which is being built on the Skagit River in Washington for the water supply of Seattle. Comparative estimates for a straight gravity dam and a constant angle arch dam were made before finally deciding the type to be built. This article compares the two types from the points of view of economy and safety and shows the superiority of the arch type. The author concludes: "The fact that no arch dam ever has failed indicates the great reserve strength in such structures as compared to gravity dams of which 69 have failed to date, mostly by sliding".

**FOUNDATION EXPLORATION IN DEEP WATER.****Dow.**

This article describes the under water exploration work carried out in connection with the Passamaquoddy Tidal Power Project. The project called for the construction of six rock-fill dams across the outlets of Cobscook Bay. The exploration work was undertaken to determine the character and depth of the clay and the underlying rock in the ocean bed where these structures were to be built. Drilling equipment fitted to derrick boats were used for obtaining samples of the clay and the rock. The equipment and operations are described in detail. The project however has since been abandoned.

*No. 17—October 21, 1937.*

**NEWS OF THE WEEK.****PURDUE BUILDS LABORATORY FOR SOIL MECHANICS.**

A modern research laboratory of soil mechanics is now under construction at Purdue University. It will embody a number of newly developed devices in soil testing equipment. Its research activities for the first two years will be confined to intensive studies of the consolidation characteristics of clays and to an attempt to develop a more satisfactory apparatus for the determination of shear.

**COMMENT AND DISCUSSION.****FAST READING STADIA ROD.**

A levelling staff which ensures faster reading and was designed at the Newark College of Engineering some years ago is described and illustrated.

**EDITORIAL COMMENTS.**

The editor in commenting on the article entitled "Comparison of Ruby Dam Designs" in which the author states that 69 gravity dams have failed while no arch dam has failed, says that the majority of failures occurred in the case of dams built in the days when dam building and designing was based on empirical methods. The failures may therefore more properly be attributed to shortcomings of engineering knowledge. Arch dams are of recent construction and their design is based on recently developed engineering knowledge.

**BAD ROCK LIMITS TVA DAM LOCATION.**

Chickamauga Dam on the Tennessee River is being built in an area where no satisfactory foundation rock can be found. Considerations which limited the location of the dam to this particular area are discussed. The foundation conditions were determined by extensive borings. The final site selected contains

so many fissures and caverns that proper preparation of foundations has presented some difficult cleaning and grouting problems. These are being solved and it is expected that an entirely water-tight and stable foundation will be secured.

#### **ELEMENTS OF CHICKAMAUGA DAM.**

Warren.

This article contains a general description of the dam. The dam consists of a concrete structure across the main channel comprising a navigation lock, a concrete spillway 960 ft. long and a power house section. The concrete structure is flanked by earth embankments 2,870 ft. and 1,410 ft. long. The spillway is of concrete gravity type 111 ft. high with eighteen gates between 8 ft. thick piers to control the flow. The earth embankments are being constructed of rolled clay. The dam will create a navigable pool extending 59 miles upstream. It will also play an important part in flood control.

#### **BEAM DEFLECTIONS WITHOUT INTEGRATING.**

Hajnal-Konyi.

The author states that Mohr's theorem can be applied directly to determine deflections of a beam under any condition of support. Complicated integrations are avoided by this method. Three examples are given to illustrate this direct application of Mohr's theorem for the determination of deflections in beams with simple and fixed ends.

#### **CIVIL ENGINEERS MEET WITH CANADIANS.**

A joint meeting of the American Society of Civil Engineers with the Engineering Institute of Canada as their guests was held at Boston on October 6-8. In the technical session three papers on difficult construction operations in Canada were presented and there were also several American papers. One of the Canadian papers described the construction of the piers of the Fraser river bridge which is nearing completion. The bridge has a central span of 450 ft. tied arch, continuous with 350 ft. side spans. The main piers resting on sand were built as open caissons in water 30 to 70 ft. deep. Difficulties caused by flood scour are described. In the course of discussion of this paper it was remarked by the President of the Foundation Company of Canada that many millions of money are wasted in carrying piers to rock when they might better be stopped at a higher level as at the Fraser Bridge. He held that flood scour might have been decreased by shaping the caissons elliptically. He considers that vibration in placing concrete should not be used in water exposure as the surface produced is less durable.

The American papers were presented under six of the Society's technical divisions and dealt with soil mechanics and foundations, city planning, pollution of river water, marine borers, and map-

ping. Two of the papers dealing with soil mechanics and foundations namely "Levees in the Lower Mississippi Valley" and "Stability of Embankment Foundations" were published in full in the Proceedings of the American Society of Civil Engineers for September 1937. Prof. Gilboy in a paper presented an excellent general review of soil mechanics knowledge as applied to several specific fields. Among other things he mentions that the view that the position of the line of saturation in earth dams depends on the permeability of the dam and can be kept below the toe is unwarranted as modern experience and soil science show. He also pointed out that the old aim to make dams watertight largely lacks justification.

*No. 18—October 28, 1937.*

#### **BUCHANAN DAM DEDICATED.**

The Buchanan flood control and power Dam on the Colorado River about 40 miles above Austin, Texas was dedicated on October 16. The dam is 11,000 ft. long and 140 ft. high and the reservoir created will impound one million acre ft. of water.

#### **CASPER CANAL PROGRESS.**

The Casper Canal of the Kendrick Irrigation Project (formerly known as the Casper-Alcova Project) extends 59 miles from the Alcova Dam on the North Platte River and will irrigate 35,000 acres of land in Casper Wyoming. The Canal is now under construction, and four electric draglines are being used for the excavation work. Nine syphons across drainage channels and six tunnels through ridges are the largest of the 150 structures along the canal, which include culverts, bridges, waste ways and lined canal sections. This article presents recent results of dragline operation, methods used in driving and lining a typical tunnel through shale, and other information regarding the aggregate being used and mixing plant and procedure. In the lining work of one of the tunnels a special sulphate resistant cement is being used as the water for mixing concrete was found to contain a high percentage of sulphates. In syphons reinforced concrete is being vibrated.

#### **BUILDING IN A BOX.**

A two storey mercantile building with exterior walls of glass tile has recently been completed in Milwaukee under unusual conditions. The work was to be rushed through in winter and as glass tile construction could not be carried out in winter conditions, the whole structure was enclosed in a plywood box with a canvas roof. Heat for the enclosure was supplied by steam unit heaters.

## UNECONOMIC PUBLIC WORKS.

The economic soundness of a number of large public works undertaken by the Federal Government as employment-producing measures was discussed at the Boston meeting of the American Society of Civil Engineers. Several papers were presented dealing with the economic factors of such projects as the Fort Peck Dam, the Passamaquoddy Tidal Power Project, Grand Coulee Project, Bonneville Project, T. V. A. dams, and the Florida Ship Canal. The authors of the papers found all of the major projects under discussion to be without economic justification and criticized the national administration for withholding from the public many of the reports which clearly showed that the projects could make no return commensurate with the large expenditure on them.

## FROM FIELD AND OFFICE.

### POND BOTTOMS SEALED BY BENTONITE.

Davis.

Ponds at the Norris fish hatchery which were losing water by bottom seepage have been made tight by the use of bentonite. Three ponds roughly square in shape and covering about 2 acres each were treated. The procedure was as follows: The ponds were drained and allowed to dry, after which the bottom was ploughed to a depth of 8 inches by an ordinary farm plough. After ploughing it was rolled with a sheep's foot roller followed by a drag to remove surface irregularities. The area was then staked in 20 ft. squares and one bag of the material containing 100 lbs. was applied in one square, that is 400 square feet. The material used was grade No. 80 KWK Volclay mined and processed at Belle Fourche. The material was spread by hand and this was followed immediately by raking the material into the top 1½ inch of soil. The bottom was then rolled again and dragged to a smooth surface and the pond was filled. It was found that in the three ponds the losses which were 350, 270, 167 gallons respectively in a certain period were reduced to 56, 32 and 17 gallons in the same period.

*No. 19—November 4, 1937.*

## SINKING CAISSONS IN DEBRIS FILL.

The express highway which is being constructed along New York City's Hudson River waterfront has presented some unique foundation problems. The highway consists of elevated steel viaducts for a major part of its total length of about 20 miles. These viaducts are carried on steel caissons and piles which were driven into a filled shore line of buried bulkheads, dumped rock and debris. The work has involved sinking of 353 steel caissons 4 ft. to 10 ft. in diameter, 143 sheeted pits for rectangular piers, and driving, evacuating and filling with concrete over 130 miles of



steel pipe piles. Main features of the work are described, and the difficulties encountered and means adopted to overcome them are mentioned.

King.

#### CONTRACT DELAYS AND INTERFERENCES.

Shields.

This article deals with the legal aspect of engineering contract work. Some decisions of the Court of Claims in cases where contract work was increased in cost by delays of Government agents are given, and practical rules are laid down for the guidance of the contractors whose contracts are unreasonably delayed or interfered with. Various examples of delay and interference which may occur are discussed, with reference to the contractor's position in such cases.

#### NEW TYPE BRUSH REVETMENT.

Trudeau.

A type of brush revetment different in construction from revetments of similar material used on the Mississippi streams has been developed on some of the streams of Western Washington. These streams are comparatively short and carry heavy loads of debris. The revetment consists of rows of stakes parallel to the bank driven at 6 ft. intervals on the river bank previously graded to a slope of 1 in 3. The rows are also 6 ft. apart except for the last two or three rows near the water's edge where spacing is varied to suit conditions. Brush mattresses are then built, first in the water, and then up to the top of the slope. The mattress is tied down to the stakes with wire. The steps involved in placing the revetment are described with illustrations, and costs are discussed. The eventual success of this type of revetment depends on silting up of the mattress, and growth of bank protective vegetation such as willows or berry bushes.

*No. 20—November 11, 1937.*

#### BIDS ASKED FOR HIGH DAM AT GRAND COULEE PROJECT.

The Bureau of Reclamation has asked for bids for completion of the Grand Coulee Dam, foundation structures for which are nearing completion. The Dam is to be 4,140 ft. long, and 553 ft. high. An overflow spillway in the central portion will be 1,650 ft. long controlled by eleven floating drum-gates each 135 ft. long and 28 ft. high. An eleven span reinforced concrete bridge will cross the spillway.

#### COMMENT AND DISCUSSION.

##### NOT A CONSTANT-ANGLE DAM.

Attention is drawn to certain erroneous statements in the article entitled "Comparison of Ruby Dam Designs" in the October 14 issue of this journal. The dam as being built is not a constant angle arch dam.

**MOIST CURING OF CONCRETE.**

Certain errors in the tabular statements accompanying the above article published in the October 14 issue of the journal are pointed out by the author.

**THIRTY YEARS OF COUNTY-ROAD PROGRESS.**

Smith.

This article describes road construction practice and organization evolved during the past thirty years in Wayne County, Michigan. Curing of concrete roads, joints, depths of pavements and other features are briefly summarized. The testing laboratory and the work carried out there are described.

**BALANCING COSTS IN WINTER CONCRETING.**

MacBride

In this article a new method is described of finding out the essential points in a winter construction programme which bring about the lowest total cost in forms, cement, construction time, and heat protection methods. It applies to concreting work done in abnormally low temperatures where heating methods and equipment are used for protecting the concrete. An example is given illustrating the use of the method for finding the most economical concrete mix, and heat curing period. Some general conclusions drawn are as follows :—

1. At subnormal air temperatures it pays to maintain concrete temperatures at 70 deg.
2. For air temperatures of 50 deg. or lower, the use of 24-hour cement on light construction work results in saving of time and heat protection costs. For higher temperatures and for mass work ordinary Portland Cement shows a favourable cost comparison.
3. With low time values and milder temperatures a leaner mix and minimum of heat protection will usually show a profit; but as time values increase and temperatures approach freezing it is best to use sufficient heat and a mix which will produce service strength within a short time.

*No. 21—November 18, 1937.*

**THE WEEK'S EVENTS.**

Shasta Dam formerly known as Kennett Dam is to be increased in size under the revised plans announced by the Bureau of Reclamation. It will be a concrete gravity structure 3,100 ft. long, and 560 ft. high. It is a part of the Central Valley Project and is to be located on the upper Sacramento River. As originally planned the dam was to be about 500 ft. high.

**SEMINCE DAM PROGRESS.**

Warner.

This article describes progress of operations at the Semince Dam of the Kendrick (formerly Casper-Alcova) Project. Diversion of the North Platte River through the recently completed diversion tunnel will enable work on the structure itself to be started. The following items have been fully completed: camp with utilities for 400 men, roads, aggregate and mixer plant, excavation of the horizontal and inclined spillway tunnels diversion tunnel, and the upstream cofferdam. The spillway tunnel consists of an inclined portion at the top followed by a horizontal portion and is 30 ft. in diameter, concrete lined. The diversion tunnel discharges into the spillway tunnel at the junction of the inclined shaft with the horizontal shaft and will be plugged off when the dam is completed. The cofferdam consists of an embankment of sand, gravel, broken rock, and earth with a timber core wall and is 60 ft. high. Brief details of camp building operations, tunnelling work, spillway work, rock excavation work for dam abutments, and construction plant are given.

**MAT-VIBRATED CEMENT MACADAM.**

Pollard.

An unusual construction process is being used in the construction of cement bound macadam pavements at Tecumseh, Nebraska. The cycle of paving operations is as follows: graded stone is spread on the subgrade, sand and cement for the grout are delivered from a mixer on to the stone. After 20 to 30 minutes, a platform of slotted mats is placed on the work and gasoline driven vibrators are wheeled over it to compact the penetrated stone and remove excess water and entrained air. The platforms are then removed and surface irregularities are corrected by adding stone chips and grout. The platforms are then replaced and the slab is again vibrated. Finishing is accomplished in the usual way by screeding. The slab produced is of high quality and penetration of the grout to the entire depth of 6 inches is carefully checked. The cement used is .9 sack per square yard of pavement and the progress is 800 square yard of pavement per day. Expansion joints are formed by creosoted boards 1 inch thick placed at 100 ft. intervals.

*No. 22—November 25, 1937.*

**THE WEEK'S EVENTS.**

A view is given of the concrete lined spillway channel of the Earth Dam at Fort Peck. The gate structure consists of 16 vertical lift gates 25 ft. high and capable of passing 250,000 c.ft. per second. Each gate is operated by an individual electric motor and from the control tower one man can lift any two gates or all together. The concrete lined spillway is 1 mile long.

## COMMENT AND DISCUSSION.

Mr. Sutherland refers to the Editor's remarks regarding arch and gravity dams in the issue of October 21 and points out that arch dams also were built, based on empirical methods of design, as long ago as 1611. He says that about one quarter of the dams of each type were built in the "empirical" period so that gravity dams are under no disadvantage for comparison. He mentions a number of inherent advantages in the use of arch dams in addition to economy.

## DEEP EXCAVATION FOR PARKER DAM.

Uncovering the bedrock for the foundation of the Parker Dam was a unique job because of the unprecedented depth of excavation as compared to the moderate height of the dam above the stream bed. The concrete dam is to be 320 ft. high of which 85 ft. is to be above stream bed, and 235 ft. below the bed of the river. This article describes the work of excavating the foundations, the difficulties encountered in the work and the remedial measures adopted. One of the main difficulties met with was seepage of water into the excavation pit and a battery of centrifugal pumps had to be employed for pumping. As the excavation went deeper more seepage took place and four 26 inch wells were sunk to bed rock, two in the upstream and two in the downstream slopes of the excavation. These were equipped with centrifugal pumps and effectively lowered the level of seepage flow. Two rows of steel sheet piling were driven in the downstream slope of the excavation to hold the ground and control the inflow. The quantity of water pumped increased from 14 cusecs to 37 cusecs by the time the bottom of the excavation was reached. The concreting plant is briefly described and progress for concreting work in the foundations made so far is given. The average rate of placing concrete is 1,700 cubic yds. per day.

## FLOOD RUNOFF FROM SMALL AREAS.

Cochrane.

"Of the numerous flood-flow formulas that exist, very few are applicable to small drainage areas, and some give values ten to twenty times too small for extreme cases of intense precipitation and quick run-off. For making approximate estimates of flood discharge and comparing one watershed with another it is desirable to have a formula containing all of the principal factors, and applicable to even the smallest areas. The formulas here presented attempt to meet these requirements. They are based on the variation in the rate of precipitation with respect to time, and they give results approximating those obtained by the use of the so-called rational methods."

## THE HIGHWAY MAGAZINE.

*November 1937.***JACKING A CORRUGATED CULVERT UNDER A PENNSYLVANIA  
STATE HIGHWAY.**

Dyke.

Collapse of a culvert under a highway near Pittsburgh led to an ingenious method of replacing it. A 36-inch corrugated Armco pipe was driven through 200 ft. of fill at a depth of 50 ft. beneath the surface of the road by means of heavy jacks. The equipment, field operations and other features of the work are described, and costs are given.

**FLOOD CONTROL IN SOUTHERN KANSAS.**

Carlson.

Cowskin creek in Kansas has long been a source of damage to farm lands and crops by floods. Flood control measures consisting of widening the creek and construction of levees on the two banks were recently initiated. Brief details of the work are given. Two 7 yard hydraulic scrapers powered with 75 H. P. tractors and a 1½ yd. dragline were used in the excavation.

**JOURNAL OF THE AMERICAN CONCRETE INSTITUTE.**

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*No. 3—January-February 1937.***PORTLAND-PUZZOLAN CEMENT AS USED IN THE BONNE-  
VILLE SPILLWAY DAM.**Clark.  
Brown.

This dam is being constructed on the Columbia River at Bonneville Oregon. Consideration leading to the decision to use a special type of low heat cement for this dam are discussed with reference to the requirements of the concrete to be placed. Preliminary tests in connection with selection of cement and results obtained are described. Finally as a result of these tests and examinations of mass concrete structures where Portland and Portland-puzzolan cements had been employed it was concluded that tendency towards cracking due to thermal changes was considerably less for the concretes containing Portland-puzzolan cements. Specifications and acceptance tests for Portland-puzzolan cements were evolved and are described, and the characteristics of the cement as purchased are set forth. Laboratory tests made in the course of routine inspection for acceptance are described and results are tabulated. These tests were designed to determine shrinkage of mortars and concrete, temperature rise of adiabatically cured concrete, thermal properties and plastic and elastic properties. Other studies made on the actual work include measurements of temperatures and strains in various blocks, stress

analysis, comparison of measured and computed strains, and stresses from final cooling. Construction experience and condition of finished concrete are then described. In the concluding remarks certain conclusions drawn from the use of Portland-puzzolan cements in mass concrete are given and it is recommended that a method of stress analysis in the design of mass concrete dams should be adopted in which the effect of thermal stresses is taken into consideration as well as stresses due to gravity and water loads.

#### EARTHQUAKES AND REINFORCED-CONCRETE.

Creskoff.

This paper deals with the distribution and frequency of destructive earthquakes in U. S. A., the origin of earthquakes, the nature of ground vibrations, their effect on structures, earthquake damage, principles of aseismic design and the characteristics of reinforced concrete which make it particularly suitable for use in earthquake-resistant construction. In conclusion, certain principles which should be observed in the design of earthquake-resistant structures are laid down, and it is mentioned that reinforced concrete is particularly suitable for such structures.

#### CEMENT AND CONCRETE STUDIES ON THE PASSAMAQUODDY TIDAL POWER PROJECT.

Casey.

The proposed Passamaquoddy Tidal Power Project necessitated extensive cement and concrete studies in view of the salt water action, intense freezing and extensive alternate wetting and drying to which the concrete used in the works would be subjected. The results of these studies are reported herein. Finally a modification of Portland cement was proposed for use as a result of the investigations. Specifications of this special cement are given.

#### CONCRETE REHABILITATION WORK ON THE UNCOMPAHGRE PROJECT.

Reeves.

The South Canal is one of the principal works of the Uncompahgre project of the Bureau of Reclamation. It has a capacity of 1,000 cusecs and consists of 6.8 miles of earth channel, 4.06 miles of concrete lined channel, five tunnels and one concrete syphon. The canal was constructed during the years 1906 and 1907. Of the 4.06 miles of concrete lined canal, 500 ft. had side slopes of 2:1, 7,000 ft. with side slopes of 1:1 and the rest with side slopes of  $\frac{1}{2}$  to 1. Approximately one half the lining was reinforced. The lining of the canal in this project failed at many places during the operation of the canal for a period of 25 years after its completion and in 1934 it was decided to carry out a rehabilitation programme of which the repairs to the lining was a part. For the portions with  $\frac{1}{2}$  to 1 slopes containing little or no reinforcement, a new lining of reinforced concrete inside the channel was placed, care being taken to secure as much bondage with the old concrete as possible. For repairing

the reinforced concrete lining guniting was used. Brief details of the works are given.

#### **DRYING SHRINKAGE OF LARGE CONCRETE MEMBERS.**

Carlson.

Describes investigations with specimens of concrete and neat cement to determine the volume changes in concrete. The application of diffusion principles to the problem of computing drying shrinkage in members of various sizes is described. The suitability of this method for predicting approximate states of drying is indicated by test data on specimens that have been under observation for 2 years.

#### **A STUDY OF SUB-AQUEOUS CONCRETE.**

Anderson.

Two methods of depositing concrete under water are now commonly used. One method uses the tremie tube which is a pipe of fairly large diameter and allows the concrete to flow from a hopper above the water surface to the interior of the submerged mass of concrete. The other method employs the drop bottom bucket which is lowered into the water with a load of concrete and when the bottom gates reach the surface under water they release the load.

The objects of the study reported herein were to compare the behaviour of concrete being deposited under water by the two methods, to compare the strengths of the concrete laid by the two methods, and to find the best mixture for sub-aqueous concrete. The methods of investigation are described, results are discussed and conclusions are given. Some of them are as follows:—

1. Tremie concrete was 17 per cent. stronger than concrete placed by the drop bottom bucket.
2. Mixes which would be considered over-sanded for concrete placed in the air give stronger sub-aqueous concrete.
3. The use of finely ground cement in sub-aqueous concrete resulted in marked increase in strength as compared to ordinary Portland cement.

### **PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.**

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*No. 7—September 1937.*

#### **MEASUREMENT OF DEBRIS-LADEN STREAM FLOW WITH CRITICAL-DEPTH FLUMES.**

Wilm.  
Cotton.  
Storey.

Heavy burdens of erosion debris in streams of the San Dimas Experimental Forest in California have been found to cause substantial errors in measurement of discharge at some of the gauging

stations where the stream flow is measured with Parshall flumes or V-notch weirs. This was due largely to deposition of debris on the level approach to the throats of the Parshall flumes during low discharge and to the filling of the weir boxes with silt in the case of the V-notch weirs. Experiments were undertaken with the object of adapting the present stations to measurement of flows under all conditions either by improving the debris-transporting characteristics of the Parshall flume or failing this, by developing a control flume that would function satisfactorily under all conditions. It was also intended to test the effect of construction modifications on the rating of Parshall flumes. The experiments were carried out in a specially constructed timber flume below the outlet gates of the San Dimas Flood Control Dam. Details of this flume and of the experimental weir and Parshall flumes constructed in this flume are described. Test procedure is explained and results are discussed in detail. Conclusions are briefly summarised as below :—

1. Construction modifications used in Parshall flumes have a negligible effect on their rating. The results indicate that the Parshall flume gives accurate results for clear, and siltladen flows containing fine material, and is reasonably accurate for measuring large flows with bed-load.
2. Presence of bed-load material substantially influences the ratings of Parshall flumes at low stages of flow, though resulting errors at high flows are small.
3. No alterations introduced into the Parshall flume succeeded in improving its accuracy in small flows with bed-load.
4. A new design of critical depth flume was evolved which appears to give accurate measurements of discharge and to be unaffected by velocity of approach or presence of bed-load. This flume functions as a broad-crested weir, and a general formula for this type has been computed.

Further model studies of this type of flume are in progress with a view to perfecting its design, and results will appear in the closing discussion.

#### PRE-STRESSED REINFORCED CONCRETE AND ITS POSSIBILITIES FOR BRIDGE CONSTRUCTION.

Rosov.

“ This paper contains a brief citation of uses made of pre-stressed steel reinforcement in the past and the development of formulas for the solution of special cases.” Basic requirements of the pre-stressed design are discussed. A mathematical treatment of the theory of pre-stressed rectangular beams is given and equations are evolved for the design of such beams. Illustrative examples are given to demonstrate the manner in which pre-stressing can influence the dimensions of a reinforced concrete structure. Tests on pre-stressed reinforced concrete members carried out



by E. Freyssinet and others are briefly reviewed and show that the deflections were small and failure occurred at loads much greater than were theoretically computed. Methods of pre-stressing the reinforcement are described. Conclusions regarding the use of pre-stressing of reinforced concrete arrived at by the author are set forth. Some of the important ones are as below :—

1. In using pre-stressed reinforcement, the tensile stresses in concrete are completely cancelled and the compressive stresses that occur over the entire cross section tend to prevent the formation of cracks.
2. Arrangement of reinforcement is simplified because the diagonal tension is appreciably less, and in continuous beams no reinforcement is necessary at the top.

#### PRACTICAL APPLICATION OF SOIL MECHANICS : A SYMPOSIUM.

The following papers are included : —

##### LEVEES IN THE LOWER MISSISSIPPI VALLEY.

Buchanan.

This paper deals with the general features of design of levees, and the use of the relatively new science of soil mechanics in solving unusual problems arising in connection with levee design. The three essential features to be considered in the design of a levee are the side slopes, foundations, and control of seepage. The slopes in use at present in the Mississippi levees are given and they vary with the material forming the levee. The river side slopes are steeper than the land side slopes. For clay soil, the river side slope is 1 : 3 and the land side slope is 1 : 6. For sand, the river side slope is 1 : 5 and the land side slope is 1 : 8. A method of designing the slope based on the principles of soil mechanics is given. For determining the stability of foundations, the direct shear test or the squeeze test on specimens of undisturbed samples can be used to obtain the ultimate strength of the material *in situ*. The stresses created by levees may be computed by a method described by Jurgenson in the Journal of the Boston Society of Civil Engineers, July, 1934. With these data it is a simple matter to determine the stability of a foundation or the necessary adjustment of design to give a desired factor of safety. Methods employed for the control of seepage are described. Seepage problems involving structures founded on pervious material are analyzed with the aid of models and the data obtained are used to estimate seepage flow and topmost flow line in the actual levee section. Other considerations in the design of a levee unit are, location of levee, source and placement of materials. The nature of the materials plays an important part in the stability of a levee. An outline of the procedure of testing soil material with a view to determine permeability,

cohesive strength, liquid and plastic limits, and moisture content is given and an illustrative example of levee design is worked out from a set of assumed basic data which in actual practice are available from soil test and site explorations.

#### QUABBIN DIKE BUILT BY HYDRAULIC-FILL METHODS.

Dore.

The Quabbin Reservoir of the Boston Metropolitan Water District will be formed by a main dam and a dike, both full hydraulic fill structures, the former being 2,640 ft. long and 170 ft. high, and the latter 2,140 ft. long and 135 ft. high. A "full hydraulic fill" earth dam is one built by transporting the material on to the dam in suspension in water, and depositing it in the dam by water, a separation of sizes taking place during deposition. The construction of a hydraulic fill dam is influenced considerably by the rate of consolidation of the core material occurring during and after sluicing operations. This paper describes mainly a method of computing this rate of consolidation developed from data in the case of the Quabbin DiKE. This method may be used for estimating core consolidation on a similar project when certain laboratory test data pertaining to the project are available.

Borrow pit material investigations in the case of the Quabbin project are described. The factors to be taken account of and the observations necessary in the control of the deposition of material in the dam are discussed. An equation to determine consolidation during construction is put forward and it is claimed that observations made on the core of the Quabbin DiKE indicate the practicability of the use of this equation. The method of use of this equation is explained. The "flow net" method was used to determine the location of flow lines through the dike in order to ascertain its requirements for water-tightness and the dimensions of the core. The locations of flow lines obtained experimentally were subsequently checked by a laboratory model. The model tests are briefly described. An equation due to Prof. Gilboy and a nomographic chart based thereon for determining the stability of the dike during construction are given and their use explained.

#### STABILITY OF EMBANKMENT FOUNDATIONS.

Hough.

This paper describes certain investigations carried out to study stress distribution in clay foundations, and the character of embankment settlement resulting from foundation stress in connection with two large rock fill embankments proposed as a part of the now abandoned Passamaquoddy Tidal Power Project. The studies relate to a cohesionless uncompacted embankment founded on a relatively uniform cohesive foundation. Foundation explorations carried out to determine the nature of the

foundation materials are described. (See also under Engineering News-Record in this Bulletin). The proposed embankments were to be rockfill structures with impervious soil blankets placed on the upstream face. An analysis of stresses created by the structures by the Jurgenson method showed that the stresses created would be greatly in excess of the strength of the foundation material. It was found that to achieve stability, the embankment base width would have to be increased five to ten times. This would be too expensive and so it was considered desirable to investigate the possibility of effecting an economy by building the embankment as originally proposed and allowing failure and displacement of the foundations to take place. To study the extent and character of the settlement to be expected, model studies were undertaken, which are described in detail. The nature of the settlement and the deformation produced were clearly indicated by the models although the results were only qualitative. Further experimentation with the models led to the development of a method of stress analysis before failure and a method of determining the extent of settlement after failure. The details of this analytical method are described in outline and some other available methods are discussed. It is considered that the method developed is more generally applicable than the existing methods. In summarizing his conclusions the author calls attention to the possibility in some instances of effecting economy in embankment design by allowing over-stress of foundations to occur rather than flattening slopes in an effort to prevent over-stress of foundations.

**SETTLEMENT OF STRUCTURES IN EUROPE AND METHODS  
OF OBSERVATIONS.**

Terzaghi.

“The methods and results of settlement observations on several structures in Europe selected to illustrate accurately the behaviour of structures on various types of compressible ground are described in this paper. Particular emphasis is given to the observation of settlements of buildings on pile foundations and the comparison between the settlement of individual piles under load tests with that of the entire pile foundation.

The form of settlement diagrams with ground conditions and loading is recommended as a pattern to be followed. The instruments and bench-marks used for settlement observations are described”.

The author discusses various aspects of settlement of buildings as revealed by observations and calls attention to the failure to obtain uniform settlements with uniform loading in both pile foundations and spread footings. A statement is included of settlement of bridge piers in Germany in various classes of soil. Settlements ranging from zero to over 3 ft. were observed even though the soil pressures were limited to allowable values.

**THE DESIGN OF ROCK-FILL DAMS.**

Galloway.

This type of dam has been developed in California and other western states during the past 75 years and in recent years some large dams of this type of over 300 ft. height have been built. The rock fill dam is composed of three elements: a loose rock fill forming the mass of the dam; an impervious face next to the water; and a rubble cushion between the two. The rock-fill is dumped loosely in position and there is no attempt at orderly arrangement of the individual lumps, nor is there any material introduced to bind them together. The weight of this mass of rock resists the thrust of the water pressure. The design of a rock-fill dam is almost entirely empirical, evolved from practice. It is not the most stable and certain type but under certain conditions specially in remote locations, the cost is usually less than for other types.

The author commences with a short historical sketch of the origin and evolution of the rockfill dam and briefly describes some of the important dams that have been built. He then goes on to describe the elements of design of such dams. The design is based on empirical knowledge gained in the past. The major elements in the design include the foundation, the nature of the rock of which the dam is to be constructed, the dimensions of the loose rock fill, settlement, the impervious facing, the rubble cushion between the facing and the rock-fill and the expansion joints in the facing. Each of the above items is discussed in detail and recommendations are given. Foundations should preferably be on solid rock. The materials composing the body of the dam should be hard solid rock which will not disintegrate under weather conditions. The material should be so placed that rock bears against rock. The section of the dam should be such that the base width is more than twice the vertical height. The downstream slope should be at the angle of repose of free falling rock, generally 1.3 to 1 or 1.4 to 1. The recommended slope of the water face is 1.3 to 1. In plan the dam should be somewhat convex to the water. The rubble cushion between the impervious facing and the rock-fill should have a minimum thickness of 15 ft. and the rubble should be carefully laid. The facing may be of timber, reinforced concrete or steel. In recent dams reinforced concrete has been used, and the thickness of the cushion is 1 per cent. of the height or more. The facing is divided into squares of 50 ft. by expansion and construction joints.

**DESIGN OF REINFORCED CONCRETE IN TORSION.**

Anderson.

This paper outlines the various steps in the design of reinforced concrete in torsion. The distribution of torsional moments and torsional shearing stress in a structure are discussed and the design of a reinforced concrete beam in torsion is given.

## ECONOMICS OF THE OHIO RIVER IMPROVEMENT.

Hall.

"Brief descriptions of the improved Ohio River are given in this paper including methods used in navigating it, and the character of the freight borne upon it. The problem presented is then stated, namely, is the public compensated for the heavy national expenditures on the improvement? Commercial navigation costs are determined as accurately as possible on a ton-mile basis for each class of freight. Government costs are analyzed on a ton-mile basis applicable to all classes of freight. The sum of these two costs is compared with rail rates, analytically and graphically. The conclusion is reached that the public has been compensated for its expenditures on the Ohio River improvement."

No. 9—November 1937.

LABORATORY INVESTIGATION OF FLUME TRACTION AND  
TRANSPORTATION.

Chang.

This paper describes a laboratory investigation of the problems of flume traction and transportation. The subject is presented under three main headings. The first part deals with investigations directed to determine the critical tractive force for a series of uniform sands of various sizes, and to study the relation between the variables involved. The second part deals with the study of transportation by traction, and the third part deals with the laws of transportation of material in suspension. The investigations were carried out in a flume 18 ft. long and 1 ft. wide with glass-sides and brass bottom. The flume with other appurtenant apparatus is illustrated, and the experimental procedure is briefly described. The tractive force investigations are first discussed and an equation has been derived for the critical tractive force in terms of the mechanical properties of the sand. The work of other experimenters is analysed and discussed and it is shown that the results obtained by them conform generally to the critical tractive force equation derived. An equation has also been presented relating Manning's roughness coefficient  $n$  with the mean diameter of the grains of the surface layer.

The experiments on transportation by traction are then discussed. An equation is presented giving the rate of sand movement in terms of the tractive force. Formulas given by other authorities including the Schoklitsch bed load formula, Fabre's formula, Meyer Peter's formula, and U. S. Waterways Experiment Station formula are reviewed. The critical tractive force formula is applied to determine the rate of transportation of bed material in a natural stream. In the course of these experiments it was found that coarser material was being dragged or rolled more rapidly than the finer. The cause of this sorting is discussed in mathematical terms.

The final part of the investigations concerns experiments on transportation of material in suspension. Suspension was noticed in the flume in as soon as saltation began. The experimental methods are described. The force required to lift a particle from the bottom of a stream is shown to be proportional to the square of the velocity. A general equation is given for vertical distribution of silt in two dimensional flow. Total silt load in suspension is discussed, and expressions are given for the mean value of silt concentration throughout a depth, and the total quantity of silt transported in suspension per second. The effect of silt transportation on velocity and stream energy is considered and it is concluded that silt transportation tends to decrease the mean velocity of flow. The 'saturation' stage of stream capacity in supporting debris is then discussed and an equation is obtained which states the general relationships that—the graded slope varies directly as the quantity of debris that must be carried, directly as the size of the material, and inversely as the discharge of the stream.

DISCUSSIONS ON THE FOLLOWING PAPERS APPEAR  
IN ONE OR MORE ISSUES OF THE PROCEEDINGS OF THE  
AMERICAN SOCIETY OF CIVIL ENGINEERS GIVEN  
ABOVE :—

PRACTICAL APPLICATION OF SOIL MECHANICS: A  
SYMPOSIUM.

RECLAMATION AS AN AID TO INDUSTRIAL AND AGRICULTURAL BALANCE.

CONSTRUCTION AND TESTING OF HYDRAULIC MODELS,  
MUSKINGUM WATER-SHED PROJECT.

GRAPHICAL DISTRIBUTION OF VERTICAL PRESSURE  
BENEATH FOUNDATIONS.

RAINFALL INTENSITIES AND FREQUENCIES.

FLOW CHARACTERISTICS IN ELBOW-DRAFT TUBES.

NATIONAL ASPECTS OF FLOOD CONTROL: A  
SYMPOSIUM.

THE PASSAGE OF TURBID WATER THROUGH LAKE  
MEAD.

PROGRESS REPORT OF THE COMMITTEE ON FLOOD  
PROTECTION DATA.

PRESSURES BENEATH A SPREAD FOUNDATION.

SOIL REACTIONS IN RELATION TO FOUNDATIONS ON  
PILES.

SELECTION OF MATERIALS FOR ROLLED-FILL EARTH  
DAMS.

**STRESSES AROUND CIRCULAR HOLES IN DAMS AND BUTTRESSES.**

**EFFECT OF DOWEL-BAR MISALIGNMENT ACROSS CONCRETE PAVEMENT JOINTS.**

**HYDRAULIC TESTS ON THE SPILLWAY OF THE MADDEN DAM.**

**ESSENTIAL CONSIDERATIONS IN THE STABILIZATION OF SOIL.**

**PRE-STRESSED REINFORCED CONCRETE AND ITS POSSIBILITIES FOR BRIDGE CONSTRUCTION.**

**THE RECLAMATION ERA.**

VOL. 27.

*No. 9—September 1937.*

**MEAD LAKE TEMPERATURE MEASUREMENTS.**

Houk.

Measurements of water temperature at different depths in Mead Lake created by the Boulder Dam have been made at monthly intervals since June 1936. The data show some interesting temperature effects in the various lake strata, particularly near the bottom of the reservoir where abnormally high temperatures are being recorded instead of the minimum temperatures usually observed at such locations. Lake temperatures are measured with an electrical resistance thermometer lowered from a launch. Temperature conditions in the major portion of the lake below a relatively shallow layer near the surface were largely controlled by inflowing Colorado River temperatures. Samples of lake water were taken and examined and it was found that the occurrence of abnormally warm water near the bottom of the lake was due primarily to the presence of a heavy load of suspended silt. Analysis of the samples made at laboratory temperatures showed an increase in specific gravity of the silty water as compared to clear water. Some of the increased temperature effects at the bottom of the lake may be directly due to the flow of the springs, as the spring water in the vicinity of the dam is found to be unusually warm. It is believed that the high temperatures of the water in the lower strata of the lake are primarily due to the arrival of warm silty water of relatively high density which has flowed along the bottom of the canyon beneath the body of the lake.

**LARGE IRRIGATION DAM IN MEXICO.**

A large storage dam is being built by the Irrigation Commission of Mexico for storing the water of the Nazas River for irrigation purposes. The dam is an earth and rock fill structure 328 ft. high and the storage capacity of the reservoir will be 3,500,000 acre ft.

**WYOMING PROJECT RENAMED.**

The Casper-Alcova project under construction by the Bureau of Reclamation has been renamed as the Kendrick project. It consists of Alcova Dam on the North Platte River and the Casper Canal which will irrigate 35,000 acres in Casper, Wyoming.

*No. 10—October 1937.*

**PROGRESS AND PROBLEMS OF FEDERAL RECLAMATION.**

Page.

This is an address delivered by the Commissioner of Reclamation at the annual meeting of the National Reclamation Association. A general account of the progress of the Federal Reclamation programme is given, and some of the most pressing problems, including the financing of reclamation, are discussed. Two types of project are being constructed under the Federal Reclamation. One is designed to rescue developed irrigation tracts from uncertain sources of supply and provide regulated stored water supply for them. The other is designed to expand agriculture on arid lands by providing water for new desert lands. At the present time 12 projects are under construction which will ultimately bring over 2 million acres of new desert lands under cultivation.

**GRAND COULEE PROGRESS.**

Describes the progress of construction at the Grand Coulee Dam. The greatest single day's concreting at Grand Coulee was 15,600 cubic yards. This has been made possible by the mechanical handling of the materials, of which brief details are given. 30,000 cubic yards of sand and gravel are delivered daily by enormous electric shovels working in gravel pits to a washing and cleaning plant. 40 per cent. of the pit output goes to waste as fine sand and the rest of the processed aggregate is delivered to stock piles by belt conveyors 5,965 ft. long at the rate of 35,000 tons a day. From the streams of sand, cement, gravel and water poured into the mixing plants, automatic scales controlled by electricity and compressed air weigh out in a few seconds the precise quantities of each component to make a 4 yard batch of concrete. Uniform high strength concrete is produced at the rate of a cubic yard in 5 seconds.

**GLENDIVE UNIT, BUFFALO RAPIDS PROJECT.**

Allotment has been made for the construction of the above project in the Yellowstone River Valley in Montana, U. S. A. The project provides for pumping water from the Yellowstone River for the irrigation of 17,000 acres of land in the river valley into a system of irrigating canals. Construction features include a pumping plant of 250 cubic feet per second capacity, 32 miles of



main canal with laterals, priming and puddling of canals, and a drainage system.

#### PROJECTS IN MINIATURE.

Sickle.

The proposed Colorado-Big Thompson<sup>1</sup> Project will divert 300,000 acre ft. of water annually from the headwaters of the Colorado River to Big Thompson, a tributary of the South Platte River, through a 13 mile tunnel, for irrigation of 800,000 acres in north eastern Colorado. It will also develop electrical power. This project met with considerable opposition from the public based on misconception. A true scale model of the Grand Lake area covered by the project was prepared and demonstrated, to convince the public and the Congress of the feasibility of diverting water from the western slope of the Continental Divide to the eastern slope without detriment to the scenic beauty of the Grand Lake and the Rocky Mountain National Park. The model, besides having an educational value, usefully demonstrated the nature of conditions more difficult to describe with maps, and it is expected to be used extensively during the progress of construction. The Bureau of Reclamation may construct a similar model for the Central Valley Project in California.

#### RETROGRESSION BELOW BOULDER DAM.

Corfitzen.

With the closure of Boulder Dam in 1935 the regime of the Colorado River below the dam has been upset and changes are taking place along the river bed as a result of nature's attempt to re-establish equilibrium. Bi-monthly studies of these changes are being made. Before the dam was closed the river discharges varied from 3,000 to 200,000 cusecs and the silt content was high, an average of about 330 tons per minute being carried past a given point. Half of the total silt load carried was finer than .0025 inch in diameter. The river bed slope was relatively stable, being about 2 ft. per mile. The clear water now flowing out of the reservoir created by Boulder Dam has the capacity to pick up and transport huge quantities of material, and consequently retrogression or removal of the sand and silt of the river bed is taking place. Observations below the dam have disclosed that the fine surface material is first removed but as soon as it becomes scarce the larger particles deeper down are moved. In the two years since the closure of the dam the average size of particles in the 12 miles of river bed below the dam has increased from .0098 to .394 inch. At a section 2 miles below the dam the bed has been degraded to a maximum depth of 12.5 ft. The degradation over the first 8 miles, which now appear to be relatively stable, is 6.7 ft. The depth to which the bed has been eroded decreases farther downstream to a point about 50 miles below the dam at which no degradation can be discerned. The point at which retrogression apparently ceases would seem to be the point at which the river has picked up as much load as it can

carry, but such is not the case. It has been observed that the river carries three times as much silt in suspension at a point 237 miles downstream as it did when it left the retrogression area. This shows that the river picks up fine silt downstream which was not available in the retrogression area. These studies point to the importance of considering retrogression action when planning intakes for irrigation works below a newly constructed dam, or in locating the draft tubes of new power plant.

*No. 11—November 1937.*

#### PLANT BEHAVIOR IN DROUGHT.

Weed.

Boulder city was built by the Bureau of Reclamation for housing the staff engaged in the construction of Boulder Dam. The town was located in an isolated and barren section of the Nevada Desert. Rainfall in this tract amounts to 3 to 5 inches a year, and temperatures are excessively high during the long summer. The author in his capacity of chief landscape gardener for Boulder city has collected a lot of information on the behaviour and growth of plants, types of plants found suitable, grass planting, irrigation procedure, and suitable fertilizers under arid conditions. In the present articles he presents his experience with planting operations under arid conditions in Boulder city. Shade trees found suitable were the Chinese elm, the poplar, the European sycamore and the ash. The best and most prolific plant growth was found to take place in air temperatures of between 50° and 76° F. The cypress was very successful as an ornamental tree. For lawns, a perennial rye grass with Dutch clover was found best suited to local conditions.

#### THE SHOSHONE CANYON CONDUIT OF THE SHOSHONE IRRIGATION PROJECT, WYOMING.

Hosig.

The Shoshone Dam on the Shoshone river forms a reservoir of 456,600 acre ft. capacity which supplies irrigation water to 67,000 acres of irrigable land at distances of 20 to 60 miles from the dam. Water for this area is let into the river at the main dam and diverted to the right and left banks by two diversion dams situated 15 and 20 miles below the main dam respectively. Additional irrigable areas totalling 90,000 acres lie above the present canals, and it is proposed to develop these areas by a high line canal system taking off above the main Shoshone Dam. This high line canal system consists of a tunnel or conduit 14,720 ft. long through the canyon wall at its commencement from the Shoshone Dam. Brief description of the rock formation through which this tunnel is to be driven is given. The tunnel will be a concrete lined horse-shoe section of 12 ft. diameter, with a capacity of 1,200 cusecs. The lower end of the tunnel is the bifurcation point of two supply channels, one for the area on each side of the canyon. One of the supply channels will cross the canyon by means of a syphon.

**JOURNAL OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL  
RESEARCH (AUSTRALIA).**

**VOL. 10.**

*No. 4—November 1937.*

Contains nothing of interest to irrigation engineers.

**JOURNAL OF THE INSTITUTION OF ENGINEERS, AUSTRALIA.**

**VOL. 9.**

*No. 8—August 1937.*

Contains nothing of interest to irrigation engineers.

*No. 9—September 1937.*

**THE PRINCIPLE OF SIMILARITY—I.**

**Hart**

“This is part I of a paper which is divided into two instalments. Section A discusses the concepts “identity” and “similarity” in geometry, kinematics, dynamics and thermodynamics. It provides a simple statement in a readily visualized form of the basic principles and their consequences. A tabular statement of the laws of similarity applicable to the four mechanical sciences above is developed.”

In recent years, the principle of similarity has become a usual and necessary tool with the engineer and investigator because of the ever increasing use of models in investigations. This paper presents a statement of the underlying principles involved in this idea of similarity and provides some demonstration of objects and processes familiar to the engineer in which the similarity principle can readily be recognized. The ideas presented have sprung from cinematographic studies of hydrodynamic phenomena carried out in a glass channel built for the Charles Kolling Research Laboratory of the Peter Nicol Russell School of Engineering.

**DISCUSSIONS AND COMMUNICATIONS.**

**THE MANNER OF FLOW OF A RIVER IN FLOOD—II.**

Comments on the above paper which was published in the May 1936 issue of the journal (See Quarterly Bulletin No. 3, page 59) by two writers and reply to comments by the author.

**CONCRETE CONTROL AS USED AT THE MOUNT.**

**BOLD DAM, SOUTH AUSTRALIA.**

A number of writers comment on the above article published in January 1937 issue of the journal (see page 107 of Quarterly Bulletin No. 5).

**CURRENT PROBLEMS IN THE USE OF BITUMEN FOR ROAD  
CONSTRUCTION.**

**Parkhurst.**

This paper describes the present position in the use of bitumens and asphalts for road construction. The subject is dealt with under six sections as follows :

1. Stabilization of soils.
2. Surfaces for light traffic. Country roads.
3. Surfaces for heavy traffic.
4. Machinery and equipment.
5. Asphalt technology and research.
6. Traffic safety.

Methods of stabilization and surface treatment used in Australia and elsewhere are described in detail. Essentials of modern asphalt equipment and the trend of present day research in asphalt technology are discussed.

*No. 10—October 1937.*

**THE PRINCIPLE OF SIMILARITY—II.**

**Hart.**

Continued from previous issue. Deals with similarity parameters in fluid mechanics, and discusses Reynolds' number as the criterion of similarity. The questions as to what Reynolds' number represents and how it governs similarity are discussed in detail. Cinematographic illustrations portraying the functioning of certain of the parameters of fluid mechanics in controlling pattern formation are given.

**PUBLICATIONS OF VARIOUS GOVERNMENTS, INSTITUTIONS,  
SOCIETIES, ETC.**

**ENGLAND.**

*Association of Special Libraries and Information Bureaux.*

**REPORT OF PROCEEDINGS OF THE FOURTEENTH CON-  
FERENCE, 1937.**

A record of the proceedings of the Conference held in Cambridge with the papers that were presented. Amongst the papers the following may be mentioned :—

1. Symposium on newspaper indexing.
2. Scientific and technical research in Soviet Russia.
3. The extent to which scientific and technical literature is covered by present abstracting and indexing periodicals.

## RUSSIA.

**TRANSACTIONS OF THE SCIENTIFIC RESEARCH INSTITUTE  
OF HYDROTECHNICS, VOL. XVII, 1935.**

Contains a number of papers in Russian. Abstracts in English are given of the following papers :—

**CONSTRUCTION OF DAMS AND OTHERS STRUCTURES BY  
DUMPING STONES INTO FLOWING WATER—DESIGN AND  
PRACTICE.**

Isbash.

The method of constructing dams and other hydraulic structures by dumping rock into flowing water has been used in a number of structures built in U. S. S. R. during recent years. Two such structures are the cofferdam in the Niva River for the construction of the Niva Hydro-electric plant and a cofferdam for the Lower Svir Hydro-electric plant. The Scientific Research Institute of Hydrotechnics carried out a series of observations and measurements at these two works and the data obtained checked up excellently with the data obtained theoretically by means of the design methods developed by the writer and described in a book entitled " Construction of Weirs by dropping stones in flowing water " published in 1932. The observations at the above mentioned works revealed some additional factors which should be taken into consideration in design. The present paper is in two parts. Part I contains information regarding the development of this method in the U. S. S. R., description of phenomena which take place when rocks is dumped, the basic problem of hydraulic design, analysis of hydrodynamic forces developed, the stability of the stones in the fill, percolation through the fill, details of method of design with graphs facilitating calculations, and methods for computing the shapes of the rock fill. Part II describes construction procedure at the Niva and Svir Hydro-electric plants and gives some additional information obtained from practical experience.

**SOME CONSIDERATIONS REGARDING THE LENGTH OF  
HYDRAULIC JUMP.**

Chertoussov.

The author analyze some experimental data on hudraulic jump from the works of Bakhmeteff and others and studies a number of empirical formulæ. He proposes a new formula for the length of the hudraulic jump, which shows very good agreement with available experimental data.

**FLOW ROUND A CUBE FIXED TO BOTTOM OF FLUME.**

Goncharov.

The author describes experiments carried out to study forces originated by flowing liquid at the surface of particles having the shape of cubes. Spectrums of forces were obtained placing ninety cubes of the same size made of lead and arranged in different ways

around a basic cube equipped with piezometers. The procedure of experiments is described and data are tabulated. The data are analyzed and conclusions are given. The conclusions and formulæ developed indicate the possibility of their application to natural bed load movement.

#### TRANSPORTATION OF BEDLOAD.

Gavrilenko.

In this paper two questions are considered :---

1. The determination of the relation between the values of Chezy's coefficient  $C$  and the roughness coefficient  $n$  on the one hand, and the size and other peculiarities of bed load on the other.
2. The development of experimental methods for investigation of interrelation of forces between the liquid stream and the bed load.

An equation for steady uniform, slowly variable flow of liquid with bed load in broad rectangular channels has been derived from which two formulæ have been developed for  $C$  and  $n$  respectively which take into consideration the effect of the bed load. A formula has also been derived for the specific resistance of bed load and all terms in the formula can be measured in the laboratory.

#### THEORETICAL PRINCIPLES OF DESIGNING TRANSIT STREAM FLOWS.

Prokofieva.  
Novotorzev.

In this paper practical methods are described for plotting transit currents flowing between two solid banks or between two zones of eddies. These methods are based on the theoretical method proposed by Bernadsky for the determination of pictures of flow.

#### SOME CONSIDERATIONS UPON STEADY SLOWLY VARIED FLOW OF LIQUIDS IN REGULARLY SHAPED NON-PRISMATIC CHANNELS.

Weiz.

Integration of the differential equation of non-uniform flow in a non-prismatic channel given in this article permits finite solutions for direct bottom slope, a horizontal bottom, and for a reversed bottom slope. It also contains transformations of the general equation applicable in certain particular cases.

#### INVESTIGATIONS OF CONCRETE IN STRUCTURES.

Glujgue.

The main purpose of this paper is the determination of methods by which the behaviour of concrete in structures can be observed. Principal phenomena occurring in mass concrete structures are reviewed as well as methods of their investigation. These include deformation and temperature changes, the composition of a concrete mixture, its permeability, etc., and the determination of modulus of elasticity and co-efficients of

thermal expansion and heat transfer in the structure itself. The status of existing methods is reviewed and recommendations are given for further improvement and development of the methods.

**ACTION OF THIN SOLUTIONS OF SULPHATES (SIMILAR TO  
NATURAL WATERS CONTAINING SULPHATES) UPON  
VARIOUS TYPES OF CEMENTS.**

**Kind.**

Describes investigations of the action of weak solutions of a number of sulphates, similar to natural waters containing sulphates, on Portland, puzzolana and slag cements. Test data show that weak solutions of all sulphates act upon the cements in the same manner. Samples of Portland cement are however fairly rapidly destroyed while samples from puzzolana and slag cements are not destroyed and harden better than in fresh water.

Other articles, of which translations are not given, are :—

Unsteady wave motion in long pools.

Determination of depth of water cushion.

Considerations regarding the overcooling of water in connection with turbulent flow in open channels.

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**INDIA.**

*Central Government.*

*Home Department.*

**INDIA IN 1934-35.**

This report is issued by the Bureau of Public Information, Government of India for presentation to Parliament. Chapter I of the report deals with agriculture and industry. The section on agriculture gives statistics of area cultivated and the area under the major crops during the year. The net area sown with crops in British India in 1934-35 was 227 million acres of which 50½ million acres were irrigated. The areas under the various major crops were as follows: Wheat 34·5 million acres; sugarcane 3·47 million acres; cotton 23·83 million acres; and rice 82 million acres. The activities of the Imperial Council of Agricultural Research are briefly reviewed. In the section on Irrigation are given statistics of areas irrigated. The total area irrigated by Government works in 1934-35 was 29·9 million acres or 12·8 per cent. of the area sown. The length of canals increased from 75,000 miles in 1933-34 to 79,000 miles in 1934-35. The area irrigated by the Lloyd Barrage System is given, and important irrigation works completed during the year are mentioned. Irrigation projects under construction are

briefly described and include the Nira Canals scheme, the Damodar Canal, and the U. P. State Tube Well Scheme.

In connection with irrigation research, mention is made of the Central Board of Irrigation and its activities.

COPY OF A PRESS NOTE ON "THE SON CANALS OF BIHAR", 6-10-1937.

This note contains a brief description of the main features of the Son Canals system in Bihar. It is one of the oldest irrigation works in India and was completed in 1891. The system consists of a weir across the river Son at Dehri, 65 miles from its confluence with the Ganges and two short canals taking off from either side which are 21 miles and 7 miles in length. The longer canal has a discharge of 4650 cusecs and the shorter one a discharge of 2350 cusecs. The commanded area is  $1\frac{1}{2}$  million acres of which over 1 million acres are cultivable. The tract was subject to frequent famines before the construction of the canals as the rainfall was inadequate and uncertain. The possibility of famine has now been eliminated and there has been an extension of cultivation. The acreage under rice and sugarcane has increased considerably and a local sugar industry has been established.

Some of the difficulties encountered during the early years of the project are described. The canals suffered seriously from immense quantities of sand and silt deposited at the heads. A special fleet of steam dredgers had to be employed to remove 6 million cubic ft. of silt each year. Later, however, as a result of long and careful study of the problem and of experiments conducted at the spot, measures were initiated which have brought the trouble within manageable limits.

UNOFFICIAL NOTE ON THE "CAUVERY METTUR IRRIGATION PROJECT", 7-11-37.

This note describes the main features of the Cauvery Mettur Project in Madras Presidency. The project consists of the Mettur Dam on the River Cauvery about 180 miles from Madras, a new canal 106 miles long taking off from the right bank of the river at the Grand Anicut 130 miles below the dam, and an extension of an old canal. The dam is a huge masonry structure 5300 ft. long, 214 ft. high, 171 ft. wide at the base and  $20\frac{1}{2}$  ft. wide at the top. It is three times the size of the Assuan Dam in Egypt. The reservoir formed by the dam is 33 miles long and  $4\frac{1}{2}$  miles wide at the widest point and covers an area of 60 square miles. The maximum capacity of the reservoir is 95,660 ft., and the water pressure exerted on the face of the dam is estimated to be 6 tons per square foot. The dam is provided with a drainage and inspection gallery 4,000 ft. long which is electrically illuminated. Expansion joints sealed with U shaped copper strips are provided in the masonry. The joints are longitudinal and spaced  $126\frac{1}{2}$  ft. apart.



The dam is provided with 4 sets of sluices with electrically operated gates. Modern machinery figured conspicuously in the construction of the dam and included two large concreting towers 306 ft. high, capable of mixing and placing 3,000 c.ft., of concrete a day.

Irrigation in the Cauvery Delta dates back to time immemorial and the Grand Anicut which was built as a solid dam by the ancient inhabitants is the key to the cultivation in the Cauvery Delta. The old irrigation system which was more or less an inundation system was defective and uncertain. The correct solution, a storage reservoir, was propounded by Sir Arthur Cotton a hundred years ago but various schemes were prepared and dropped for one reason or another since that time, until the present project was drawn up and finally approved in 1925. The project, besides providing a dependable supply for irrigation of the Cauvery Delta, will also irrigate a large fertile elevated tract in the south of the Tanjore District which had no means of irrigation from the river owing to its altitude. This new area is estimated to be 301,000 acres.

The project will generate electricity, and will also play an important part in the control of floods in the Cauvery Delta.

UNOFFICIAL NOTE ON "THE LLOYD BARRAGE SYSTEM  
(SIND)", 26-11-37.

This note describes important features of the Lloyd Barrage Project in Sind which was completed a few years ago. It is one of the most remarkable irrigation works of the World and is already functioning efficiently and providing a livelihood for two thirds of the population of the Province of Sind directly and indirectly. The scheme consists of a barrage across the River Indus five times the length of London Bridge, with 7 canals—3 on the right and 4 on the left bank, taking off from it. The barrage is constructed of creamy white limestone with arches of cement concrete and has 66 spans of 60 ft. each, carrying two bridges, one for traffic and the other for operating the gates. The gates are ordinarily operated by electricity though they can be operated by hand also. The canal system is the largest in the world comprising 6,547 miles of channels and 47,773 miles of water-courses. The largest of the 7 canals exceeds the Panama Canal in width at bed level. The total area commanded is  $7\frac{1}{2}$  million acres of which  $6\frac{1}{2}$  million acres are cultivable, and  $5\frac{1}{2}$  million acres are expected to be irrigated annually. The total cost of the scheme was slightly under 20 crores of rupees. The net return expected is 3.73 per cent. on the capital outlay 10 years after completion, in 1942-43, and 7.39 per cent. ten years later.

Profit was not the object with which the scheme was undertaken. The main idea was to replace the old precarious system of irrigation with inundation canals by a modern efficient and dependable

system. When the scheme is in full operation the area under cultivation will be three times the area cultivated before the construction of the scheme.

The work in itself was of a stupendous nature. The labour employed on the works varied from 30,000 to 50,000 during the working season. For mechanical transport 42 miles of broad gauge and 24 miles of narrow gauge railway track were laid. Other mechanical equipment included 2 dredgers, 2 paddle tugs, and a number of mechanical excavators. 752 crores of cubic ft. of earthwork were done and nearly 2,000 bridges, regulators syphons etc., had to be built. The inhospitable climate with abnormally high temperatures prevailing during the long summer added considerably to the difficulties of carrying on work during the nine years of construction. The work was spread over an area of 12,000 sq. miles—a large part of which was desert, notorious for its inaccessibility and lack of water supply. At several places water had to be pumped from the river or old channels to a distance of 4 to 6 miles for construction works and equipment.

The idea of an improved irrigation system in Sind originated soon after the British occupation of the Province in 1843 and various schemes were prepared from time to time until the year 1918 when abnormally low supplies in the river brought about a complete failure of the old inundation canals, and there was very little cultivation, resulting in widespread famine conditions. Conditions threatened to be as bad again in 1920 and the project was expedited and finally approved in 1923.

UNOFFICIAL NOTE ON "THE TANDULA CANAL (CENTRAL PROVINCES)", 12-12-37.

This irrigation Project of the Central Provinces was prepared in 1907 and sanctioned in 1909. Construction began about the middle of the following year and was completed in March 1923 although it has been functioning since 1917-18. The scheme is intended to protect a portion of the Drug district against famine and commands a gross area of about 675,000 acres, of which a little over 600,000 acres, including 216,000 acres of paddy land, are culturable. The scheme is not a paying proposition yet, as arrears of interest are still being paid off. The capital expenditure up to the end of 1935-36 was about Rs. 124 lakhs. The gross receipts for that year were nearly 3 lakhs and the net revenue a little over Rs. 1½ lakhs.

The scheme comprises a twin reservoir on the Sukha and the Tandula rivers formed by damming the rivers just above their confluence and a canal nearly 69 miles long, with about 523 miles of distributaries. Both the dams are of earthwork and the reservoirs are separated from each other by a rocky spur which has been cut through to connect them, and on which the waste weirs and spill channel are situated. The reservoir on the Sukha is 1½

miles long with a dam 72 ft. high, and that on the Tandula is about  $1\frac{1}{4}$  miles long with a dam 82 ft. high. The reservoirs have a catchment area of 319 sq. miles and are together capable of storing 9,712 million cubic feet of water which is available for irrigation. The canal at its head is capable of discharging nearly 2,200 cusecs.

*Department of Commercial Intelligence and Statistics.*

AGRICULTURAL STATISTICS OF INDIA, VOL. II, 1934-35.

This is an annual publication of the Government of India which give figures of areas under irrigation, areas under crops, numbers of live stock, and land revenue assessment, in Indian States. Vol. I of the same publication contains similar information for British India (see page 114 of Bulletin No. 6).

The largest area irrigated from all sources during the year was in Hyderabad State while the largest irrigated area from Government Canals was in Bahawalpur State in the Punjab. The total area irrigated by Government Canals in the Indian States during the year was 3,559,000 acres.

*Railway Department (Railway Board).*

REPORT OF THE INDIAN RAILWAY ENQUIRY COMMITTEE,  
1937.

The Indian Railway Enquiry Committee was appointed in October 1936 with Sir Ralph Wedgwood as Chairman to examine the position of Indian State owned Railways and to suggest measures to secure an improvement in net earnings and place railway finances on a sound remunerative basis. This is the full report of the Committee. A summary of conclusions and recommendations is given at the end. The Report contains the following remarks :—

“ As we see it the Indian railways are well organised for conducting railway transport with economy, and with operating efficiency ; but they are ill organised and ill equipped on what is known as the commercial side—that is, on the side of creating and developing traffic, of securing and maintaining friendly relations with the traders and trading bodies, and of cultivating good public relations generally. We regard this as a serious misfortune, and we hold that the first duty of the Indian railways at the present time is to take every measure possible to remedy this defect ”.

“ The primary business of a railway is not to spend money nor even to save money but to earn it ; and as a means to earning money, it must be free to spend it ”.

“The decision to construct a competitive road should rest with the Central Government and the Provincial Governments in consultation, and the responsibility of Agents should be confined to estimating the diminution in railway traffic which it would entail”.

“Provinces should draw up a long term programme of road construction and settle in consultation with the Central Government the order of priority in which the works should be undertaken”.

“We consider it essential that railways should have full powers, on the same terms as other road users, (a) to run road services ; (b) to invest money in or enter into working agreements with road transport undertakings ; and (c) to arrange road transport services through contractors”.

“We think it regrettable that railways have made no attempt to establish themselves on the roads, and give our reasons for that view”.

*Department of Education, Health and Lands.*

ANNUAL REPORT OF THE PUBLIC HEALTH COMMISSIONER  
WITH THE GOVERNMENT OF INDIA FOR 1935, VOL. I.

In section I amongst other things, rainfall conditions, and agricultural and economic conditions are discussed. A table of rainfall in inches in each quarter of the year 1935 in various Provinces of India is given. Another table shows the cultivated and uncultivated acreage in the different Provinces for the years 1934-35 and 1935-36.

The section on Public Health works gives details of expenditure on public health works and mentions important works carried out in the various Provinces.

Attention is drawn to the rapid increase in the population of this country which is estimated to reach 400 millions in 1941.

*Imperial Council of Agricultural Research.*

IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH,  
CONSTITUTION OF THE COUNCIL, RULES AND REGULATIONS OF THE COUNCIL, MEMORANDUM OF ASSOCIATION OF THE COUNCIL, AND BYE-LAWS OF THE COUNCIL.

REPORT ON THE DEVELOPMENT OF THE CATTLE AND  
DAIRY INDUSTRIES OF INDIA.

Wright.

This is a report by Dr. Norman C. Wright, Director, Hannah Dairy Research Institute, Ayrshire, Scotland, who came out to India and toured the country in the capacity of Expert Scientific Adviser (Dairying), to advise the Government on the method and means of developing the cattle and dairy industries of India.

PROCEEDINGS OF THE FIRST MEETING OF THE RICE  
COMMITTEE APPOINTED BY THE IMPERIAL COUNCIL  
OF AGRICULTURAL RESEARCH, JANUARY 1937.

In accordance with the recommendations of the Crop Planning Conference held in June 1934, the Imperial Council of Agricultural Research have constituted two standing committees on rice and wheat which will consider all matters pertaining to the productions, marketing and general improvement of the two crops. The proceedings of the first meeting of the Rice Committee are reported herein. Items on the agenda are classified under two heads, research and economics. A research sub-committee was appointed to deal with the research portion of the agenda. Progress reports on rice research schemes, future programmes of work under these schemes and notes by some Governments and members dealing with various aspects of rice research were considered by this sub-committee. Under the economics section the committee discussed amongst other items the necessity of a survey to get reliable information on crop area statistics. It was mentioned that aeroplane photography was capable of providing reliable data expeditiously, specially in areas where accurate village maps do not exist. The committee also discussed the effect on crops of Paris Green used for anti-malarial work. Experiments are in progress in some Provinces to study this problem.

The research sub-committee considered amongst other items a note on the low yield of rice in India and means of increasing it. Another note discussed was on the water requirements of rice for which experiments were in progress in Madras, United Provinces and Bihar. A note by the Sind Government mentions that a large scale "duty" experiment was carried out last year to determine the adequate "duty" of rice cultivation in the Fuleli Canal tract and gave valuable results indicating the actual water requirements of the rice crop during the various stages of growth. A note from the Government of Travancore describes experiments carried out on reclamation of alkali soils by using different kinds of sour leaves such as tamarind etc., for treatment of the soil. The experiments showed that such treatment has a considerable effect in diminishing the alkalinity.

EXTRACTS FROM THE REPORT OF THE BOTANICAL SUB-  
COMMITTEE HELD AT NEW DELHI ON THE 27TH  
JANUARY 1937.

This extract gives the decision of the Botanical Sub-Committee on the surveys of plant breeding material. It was decided to collect information regarding the range of variability in all characters of the cotton and rice crop and two small committees for doing the work on rice and cotton respectively were appointed.

**EXTRACTS FROM THE PROCEEDINGS OF THE ADVISORY  
BOARD OF THE IMPERIAL COUNCIL OF AGRICULTURAL  
RESEARCH, 28TH JANUARY 1937.**

These extracts deal with the action taken by the Advisory Board on the annual progress reports of rice research schemes, future programme of work of such schemes, and effect of Paris Green for anti-malarial work on crops. The recommendations of the Rice Committee regarding these were approved. (See Proceedings of the first meeting of Rice Committee in this Bulletin).

**EXTRACTS FROM THE PROCEEDINGS OF THE MEETING  
OF THE ADVISORY BOARD OF THE IMPERIAL COUNCIL  
OF AGRICULTURAL RESEARCH, 28TH JANUARY 1937.**

Discussion at the meeting on surveys of plant breeding materials and the recommendation of the Botanical Sub-Committee to start work on rice and cotton.

**NOTES PREPARED BY DR. NORMAN C. WRIGHT THE  
EXPERT SCIENTIFIC ADVISER (DAIRYING) REGARD-  
ING THE SCHEMES OF WORK SPECIFICALLY MENTIONED  
IN HIS TERMS OF REFERENCE AND A NOTE BY  
COLONEL SIR ARTHUR OLEVER, THE ANIMAL HUS-  
BANDRY EXPERT TO THE IMPERIAL COUNCIL OF  
AGRICULTURAL RESEARCH, SETTING OUT CERTAIN  
POINTS ARISING OUT OF THE REPORT BY DR. WRIGHT,  
FOR THE CONSIDERATION OF THE ADVISORY BOARD OF  
THE COUNCIL.**

These notes deal with animal husbandry.

**CHART SHOWING THE PROGRESS OF ACTION TAKEN OF  
THE RECOMMENDATIONS OF THE RICE COMMITTEE  
APPOINTED BY THE IMPERIAL COUNCIL OF AGRICUL-  
TURAL RESEARCH.**

One of the recommendations of the Rice Committee arising out of a discussion of a note regarding water requirements of rice was that the Central Board of Irrigation should be approached for any information regarding experimental data on water requirements of rice.

**REPORT ON THE WORK OF THE IMPERIAL COUNCIL OF  
AGRICULTURAL RESEARCH IN APPLYING SCIENCE  
TO CROP PRODUCTION IN INDIA.**

**Russell.**

One of the conditions laid down when the Imperial Council of Agricultural Research was instituted was that its work should be periodically reviewed by some disinterested expert. Sir John Russell was the first expert to be appointed to report on the work of the Council. The report is in two parts. Part I is a general review of agricultural conditions in India with special

reference to the difficult problems associated with the improvement of agriculture and the raising of the standard of life of the cultivator. The work of the Council in this connection is also reviewed and many suggestions are made for improving existing conditions. The crops of India are described and the work done in improving the crops is reviewed. The increase in area under each crop such as sugarcane and cotton is very large compared with the area under food crops. The acreage under rice is apparently declining and sample surveys are recommended in order to obtain definite information on the matter. Factors improving the yields of crops are discussed and recommendations with regard to methods of improving the yields are made. One of the factors which improve the yield is better control of water supply. In discussing irrigation in relation to agriculture Sir John Russell mentions some problems met with. These are the designing of new cropping schemes to permit the best use of the water available, best times for irrigating and optimum quantities to apply. In planning new canal schemes, the proposed cropping scheme should be carefully studied because there must be an adjustment of cropping scheme to the available supply to obtain best results. Other problems mentioned are the soil problems in canal irrigated areas, such as waterlogging and alkali problems. He states that it may be laid down as an absolute rule that no irrigation scheme should ever be carried out until a soil survey of the region has been made. All the various problems are being studied at some or other of the research stations and the work is scattered. He therefore strongly recommends the establishment of a central irrigation research station to undertake investigation of all agricultural problems associated with irrigation.

The causes of soil erosion are then discussed and methods of controlling the erosion are mentioned. Better use of manures and fertilizers is necessary for improved agriculture, and manurial trials at the experiment stations need to be more systematic. Special difficulties confronting the Indian agriculturist are described, and possible methods of removing these difficulties are indicated. To deal more effectively with the problems mentioned above the creation of a Development Commission is suggested which would deal with soil conservation, deterioration and erosion, planning of cropping schemes, improvement of grazing land, exploitation of processes of commercial importance, multiplication and distribution of seeds of approved varieties, and improvement of village roads.

Sir John Russell points out very forcibly the necessity for bridging the gap between the research worker and the cultivator. He finds that considerable advance has been made in research in Indian agriculture, but very little use is being made of it by the cultivator, and advocates the concentration of attention on persuad-

ing the cultivator by means of demonstrations, or other methods, to adopt the improvements recommended by the Agricultural Departments.

The work of the Imperial Agricultural Research Institute at New Delhi is reviewed and it is suggested that the Institute should take up at an early date work on the method of sampling soils, collection and examination of soil analysis in different parts of India, and experiments on the relative values of nitrogen in green manure, farmyard manure, compost, etc.

Part II of the Report deals with the individual schemes fostered by the Council in various parts of India and sets forth various recommendations for improving the work being carried out. It also contains a brief note on the Punjab Irrigation Research Institute, Lahore, visited by Sir John Russell and the different problems being investigated there. It is mentioned that no investigations of the optimum quantities and times of application of water to different crops are carried out though the subject is extremely important. Soil examination methods devised by Dr. Puri are mentioned but it is advised that wherever possible standard methods recommended by the International Society of Soil Science should be used by Indian workers because then only can results be compared with those obtained in other countries and with studies by other soil workers.

A summary of the Report and general recommendations are given at the end.

### *Imperial Agricultural Research Institute.*

#### SCIENTIFIC REPORTS OF THE IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI FOR THE YEAR ENDING 30TH JUNE, 1937.

This contains reports of the agricultural research work carried out at New Delhi and Karnal. A review of three decades of research at the Institute which was first situated at Pusa and was shifted to New Delhi in 1936 is given. The work includes crop experiments, manurial trials, rotational experiments, test and design of machinery and implements, breeding improved crops, researches in soil science and agricultural chemistry, water requirements of crops, plant nutrition, bacterial and other diseases of plants, insect pests and control, and the bio-chemistry of crops. Reports by the Imperial Agriculturist, the Imperial Economic Botanist, the Sugarcane Expert, the Imperial Agricultural Chemist, the Imperial Mycologist and the Imperial Entomologist on the work carried out under them at various substations, and the future programmes of work are included.



**REPORT OF THE DIRECTOR, IMPERIAL AGRICULTURAL  
RESEARCH INSTITUTE, NEW DELHI FOR THE YEAR  
ENDING JUNE 30, 1937.**

This is a reprint of the report from the Scientific Reports of the Institute for the year ending June 1937 and deals with the work carried out by the Institute in general, statement of accounts and a review of the work carried out at Pusa and New Delhi during the last 3 decades.

*Forest Research Institute.*

**FOREST IN RELATION TO CLIMATE, WATER CONSERVATION AND EROSION. (EXTRACTS FROM THE PROCEEDINGS OF THE BRITISH EMPIRE FORESTRY CONFERENCE, SOUTH AFRICA, 1935).**

This publication contains the report of the Committee on forests in relation to climate, water conservation, and erosion, appointed by the Empire Forestry Conference in South Africa, and the debate on the report and the Conference. A paper on "Soil Erosion in India and its consequences", by Messrs. Glover and Hamilton presented at the Conference, is also given.

The report of the Committee deals with the effect of forests on temperature, wind, rainfall, humidity, evaporation and climate in general. It is stated that forests exert a moderating influence on extremes of heat and cold and on the adverse effect of winds, increase humidity, retard evaporation, and have generally an ameliorating effect on climatic factors. With regard to rainfall it is pointed out that topographical features of a country exercise a far greater influence upon precipitation than forests alone which have however some influence on the local distribution of rainfall.

The effect of forests on various aspects of water conservation is next considered. The first influence of destruction of forests is on the moisture content of the soil, the diminution of perennial streams, increase of floods, deposit of detritus by wind and water, and gradual reduction of cultivation. Instances are quoted of rivers in India and elsewhere which were previously navigable by sea-going ships but now can be navigated by small boats only. The decay of the great irrigation works of Mesopotamia is due to the neglect of catchment areas of the Euphrates and Tigris. In the case of reservoirs and dams, the influence of forest cover in the catchment areas would be beneficial by decreasing run-off and preventing silting. The silting problem in denuded areas has been causing the greatest anxiety to irrigation engineers. The silt laden water does not penetrate into the soil and causes large floods which run to waste. Forests have a regulating effect on stream flow, decreasing the flood and increasing the flow of water in dry seasons when streams in a denuded area altogether dry up.

The effects of forests on erosion is next discussed. The disastrous effects of erosion following destruction of forest cover are admitted by all authorities.

In the course of the debate, Mr. Trevor, the Inspector General of Forests in India draws attention to the erosion of the outer Himalayas by excessive grazing and cutting down of the forests. Other speakers give their experiences in South Africa and elsewhere.

The article on "Soil Erosion in India and its Consequences" gives a brief account of the topographical features of India, rainfall, and population. The conditions prevailing in the Punjab foothills are then discussed in detail and the causes of the present erosion conditions are set forth. Possible methods of dealing with the erosion problem are indicated.

#### THE FOOT-HILLS GRAZING PROBLEM IN INDIA.

Corrie.

This pamphlet has been issued by the Imperial Council of Agricultural Research and contains an article reprinted from "Agriculture and Livestock in India", September 1937 (see Bulletin No. 7, page 54).

*Department of Industries and Labour. (Public Works Branch).*

REVIEW OF IRRIGATION IN INDIA, FOR THE YEAR 1910-11.

REVIEW OF IRRIGATION IN INDIA, FOR THE YEAR 1911-12.

REVIEW OF IRRIGATION IN INDIA, FOR THE YEAR 1912-13.

REVIEW OF IRRIGATION IN INDIA, FOR THE YEAR 1913-14.

REVIEW OF IRRIGATION IN INDIA, FOR THE YEAR 1914-15.

STATEMENTS SHOWING THE FINANCIAL RESULTS OF PRODUCTIVE AND UNPRODUCTIVE IRRIGATION, NAVIGATION, EMBANKMENT AND DRAINAGE WORKS FOR, AND UP TO THE END OF, THE YEAR 1935-36.

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#### BENGAL.

*Department of Agriculture.*

ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE, BENGAL, FOR THE YEAR 1936-37. PARTS I AND II.

Part I contains reports on administration and works carried out in different sections namely fibre section, chemical section, botanical section, agricultural engineering section, entomological section. Research and experimental works carried out are mentioned. Three methods of mechanical analysis of soils are being experimented upon under instructions from the Imperial Council of Agricultural Research, namely the Truog, the International, and the new Dacca University methods.

**Part II** contains detailed reports of the heads of the various sections mentioned above together with reports on certain important farms. Research and experiments on rice, sugarcane, jute and cotton are mentioned. Soil work included the comparative study of different methods of soil analysis, and soil surveys of certain areas near the sea which are going out of cultivation due to the appearance of a poisonous substance called Kasch. It has been found that in the affected area plants and vegetable matter in different stages of decomposition are buried under the earth sometimes only three inches below the top soil. This decomposed vegetable matter is supposed to be responsible for the poisonous effect, and possible remedies have been suggested.

## BIHAR AND ORISSA.

### *Irrigation Department.*

#### **ANNUAL ADMINISTRATIVE REPORT FOR IRRIGATION IN BIHAR AND ORISSA FOR THE YEAR 1935-36.**

The canal systems in the Province irrigated a total area of 940,248 acres during the year under review as compared with an average of 871,712 acres during the preceding three years. The Son canals which have been classified as a productive work from 1st April 1934, yielded a net return of 5.29 per cent. on the capital during the year. The Orissa canals were worked at a loss of about 7½ lakhs of rupees. On the whole, however, there was a surplus revenue of about Rs. 1,20,000 after meeting working expenses and interest charges during the year. Statements of area irrigated, navigation traffic, financial results, and works expenditure are included.

#### **PROCEEDINGS OF THE COMMITTEE FORMED TO CON- SIDER THE MATERIALS COLLECTED BY THE WATER- WAYS ENGINEER CONCERNING FLOOD CONDITIONS IN NORTH BIHAR, 1937.**

The Committee was appointed to consider flood conditions in Champaran, Muzaffarpur and Darbhanga Districts in North Bihar, and to suggest measures for flood relief. Three rivers, the Bagmati, Bur Gandak, and Sikrana are mainly responsible for floods in these tracts. The Committee discussed a number of communications addressed to them by various concerns including the Bihar Planters' Association and the Champaran District Board. The Committee also inspected certain road embankments which are alleged to cause obstruction of flood flows, and certain sections of the Bengal and North Western Railway in which the waterway provided is alleged to be insufficient. A few other localities and existing river embank-

ments were also inspected and after final discussions the Committee came to the following important conclusions with regard to measures for flood relief :—

1. Increasing the waterway in several reaches of the Bengal and North Western Railway line. The afflux at some of the bridges in these reaches was as high as 3' and 4.5' ft.
2. Construction of a 20 mile long embankment along the left bank of the Sikrana River.
3. Lowering of certain road embankments and provision of control shutters in some of the large drainage culverts in one road embankment which has recently been raised as a flood embankment.
4. Absolute prohibition of fishing " bands " in any of the Bagmati River channels as they obstruct the formation of a regular channel.

The Committee also reviewed in general the material collected by the Waterways Division which was created in 1934 to collect data on flood conditions. A statement of investigations carried out and proposed by the Waterways Division is attached.

#### REPORT OF THE MONGHYR (BEGUSARAI) ADVISORY FLOOD COMMITTEE, 1936.

" This Committee was formed to ascertain the causes of severe flooding in the rains of August 1936, in and in the neighbourhood of Begusarai and to suggest any practical relief for the future, of a part or whole of the area flooded."

The flooded tract lies on the left bank of the Ganges and extends up to the railway embankment which runs more or less parallel to the river at a distance varying from 3 miles to six miles from the river. An old " Bandh " or embankment known as the Gupta Bandh which lies on the left bank of the Ganges was 11½ miles long in 1920, but is being cut away by the eroding action of the river so that in 1936, its length was 8 miles. The Committee inspected this bandh and two other roads which were reported to cause obstruction to the flood waters. They came to the conclusion that a retired line of embankment should be constructed from a point on the old Gupta Bandh to the railway embankment which would shut off the town of Begusarai from the flood waters. They also recommend the lowering of two road embankments to ground level as the embankments obstruct the free passage of flood water. They were of opinion that the heavy erosion of the Ganges on the left bank appears to be due to natural causes and not to the works of the Indian General Steam Navigation Company. As a precaution, however, they suggest certain restrictions on the building of jetties and the plying of steamers in the river by the Company.

**REPORT OF THE SARAN ADVISORY FLOOD COMMITTEE,  
1936.**

The Committee was appointed to ascertain the causes of the severe flooding in August 1936, in a large tract of the Saran District and to suggest any practical methods of relief for the future. The flooded area consists of a strip of land about 80 miles in length and six miles in width lying on the left bank of the Gogra from its junction with the Chhoti Gandak and the Ganges, and then on the left bank of the Ganges upto the junction of the Gandak and the Ganges. The Committee made a detailed inspection of the flooded area and existing embankments, and came to the conclusion that flooding has been due to the spilling of Chhoti Gandak and the Gogra on their banks. Their principal recommendations are :—

1. Raising two roads, one running along the left bank of Chhoti Gandak, and the other running along the left abank of the Gogra from the mouth of Chhoti Gandak to the confluence of the Gogra and Ganges. The length to be raised in the former is about 2 miles and in the latter about 33 miles. These raised roads will prevent the flood from spilling over the area affected. The raising of the road embankment along the river Gogra, however, may be objected to by the United Provinces Government as the district of Ballia in the United Provinces is on the other side of the Gogra and may be adversely affected by the raising as recommended.
2. Another recommendation is the strengthening of a bundh which runs at right angles to the direction of the river from the confluence of the Gogra and Ganges for a distance of about 5 miles.

**REVENUE REPORT OF THE GOVERNMENT OF BIHAR  
AND ORISSA, IRRIGATION DEPARTMENT, FOR THE  
YEAR, 1935-36.**

Contains a general review of irrigation and navigation works, embankments, and drainage works. Statistical tables showing financial results, areas irrigated, water rates in force, demands and realization, and traffic on canals are given.

**UNITED PROVINCES.**

*Public Works Department. (Irrigation Branch).*

**ADDRESS BY SIR WILLIAM STAMPE, CHIEF ENGINEER,  
IRRIGATION DEVELOPMENT, U. P., ON THE OCCASION  
OF THE OPENING CEREMONY OF THE CHITAUAR  
POWER STATION BY HIS EXCELLENCY THE GOVERNOR  
OF U. P., ON NOVEMBER 2, 1937.**

Stampe.

Sir William Stampe's address describes briefly the inimial objects of the Ganges Canal Hydro-electric Grid Project whereby power is developed at a number of falls on the Ganges Canal and is

utilized over a large agricultural area. These objects were—the electrification of 88 towns, supply of power for pumping from rivers for irrigation, power for pumping from tube-wells for irrigation, and energizing agricultural machinery in farms. He then goes on to discuss cost of generation and financial return. The total cost of generation is Rs. 1209 per k. w. of which about two thirds represents the cost of a transmission system 4,000 miles in length. Two thirds of the gross output of 29,000 k. w. is allotted for irrigation pumping. Nett return for the current year is estimated at nearly Rs. 4 lakhs. In urban areas current is retailed at fixed rates through licensees who instal their own distribution system. A brief history of the inception of the State Tube Well Scheme is outlined and the operation of the tube-wells is reviewed. 1,490 wells and subsidiary works have been completed at a cost of Rs. 138 lakhs. Further developments possible with cheap power available for the uplift and welfare of the rural tracts are indicated and mention is made of further resources which can ultimately be utilized for power development. Finally, acknowledgment is made of the services of officers connected with the completion of the scheme.

ADDRESS BY SIR WILLIAM STAMPE, CHIEF ENGINEER, IRRIGATION DEVELOPMENT, U. P., ON THE OCCASION OF THE OPENING CEREMONY OF THE UPPER GANGES CANAL FEEDER TUBE WELLS BY HIS EXCELLENCY THE GOVERNOR OF U. P., ON NOVEMBER 2, 1937.

Stampe.

Attention is drawn to periodical shortages in supply in the older canal systems. Investigations indicated that cheap power from the Ganges grid could be utilized to pump water from tube wells to supplement the canal supplies in times of shortage. Two projects of an experimental nature were carried out in this connection, in the first of which two distributaries were cut off from the canal and fed by large tube wells. In the second, the tail portion of a distributary was abandoned and replaced by a system of tube wells. Results of these experimental projects are being watched. To supplement the Ganges Canal in times of shortage thirty tube wells pumping 100 cusecs directly into the canal were constructed. The wells are operated during those hours of the day when the hydro-electric system is not otherwise loaded to its maximum output. Cheap surplus current is utilized for supplementary pumping during these hours and the additional water is being utilized for irrigation in the Mat Branch in the districts of Muthra, Agra and Aligarh where construction of tube wells is not feasible for geological reasons. Important experiments are in progress to determine to what extent the water abstracted from tube wells is drawn, in the form of additional seepage, from the canal itself.

**THE GANGES CANAL HYDRO-ELECTRIC SCHEME WITH  
ITS ASSOCIATED STATE TUBE WELL IRRIGATION  
PROJECT: BRIEF NARRATIVE OF THE HISTORY,  
OBJECTIVE AND SCOPE OF THE PROJECTS.**

Stampe.

The Upper Ganges Canal in the United Provinces commands an area of  $4\frac{1}{2}$  million acres and irrigates 1,200,000 acres. It has thirteen falls of 7 to 10 feet of which ten were considered suitable for power development. Features offering economic advantage for a power system developed from this canal system are described. The completion of the permanent headworks of the Ganges Canal in 1920 and of certain remodelling works in 1926, assured a continuous supply on the canal, and investigations of power development projects on a number of falls were undertaken in 1926. The grid scheme was started in 1928, and the stages of its progress are briefly reviewed. The grid scheme was reviewed by an Enquiry Committee in 1934, and another Committee of Experts in 1935, and the conclusions of these committees are given. The grid scheme comprises seven canal power stations supplemented by a steam station as a standby. The four types of transmission lines are described. The capital cost and the cost of production per kilowatt are given. The capital cost per kilowatt installed is Rs. 440 for the hydro-electric installations while the cost for the standby steam installation is Rs. 210 per kilowatt. At the steam station every unit generated costs two pies for coal. Criticisms of the high capital cost and high cost of grid current have frequently been made. These are discussed and their lack of justification is shown. Brief descriptions of the rural distribution system and the State Tube Well System follow and details of the actual development of irrigation and cost per acre are given. Advantages of tube wells apart from irrigation are mentioned. The extent to which these schemes contributed to the relief of unemployment is stated and criticisms as to the purchase of equipment from outside India are disposed of.

**CENTRAL PROVINCES.**

*Department of Agriculture.*

**REPORT OF DEMONSTRATION WORK CARRIED OUT IN  
THE EASTERN CIRCLE TOGETHER WITH REPORTS ON  
THE SEED AND DEMONSTRATION AND CATTLE-BREED-  
ING FARMS OF THE CIRCLE FOR THE YEAR ENDING  
THE 31st MARCH, 1936.**

The demonstration work included varietal tests of paddy, wheat and sugarcane, manurial tests, and growing of garden crops.

**REPORT ON DEMONSTRATION WORK CARRIED OUT IN THE NORTHERN CIRCLE TOGETHER WITH REPORTS ON THE SEED AND DEMONSTRATION AND CATTLE-BREEDING FARMS OF THE CIRCLE FOR THE YEAR ENDING THE 31ST MARCH 1936.**

**REPORT ON DEMONSTRATION WORK CARRIED OUT IN THE SOUTHERN CIRCLE TOGETHER WITH REPORTS ON THE SEED AND DEMONSTRATION AND CATTLE-BREEDING FARMS OF THE CIRCLE FOR THE YEAR ENDING 31ST MARCH 1936.**

## PUNJAB.

*Public Works Department, (Irrigation Branch).*

**HISTORY OF THE LOWER CHENAB CANAL HEADWORKS AT KHANKI FOR THE YEAR 1935-36.**

Rainfall during the year was abnormal, i.e. 34.49" as compared with 28.59" last year and 35.29" during 1933-34, which was the wettest year during the past twelve years.

As regards changes in the course of the river, the right creek has developed into a powerful arm of the river due to the functioning of the right bank undersluices, and this change has been a factor in the improvement of silt conditions in the canal.

The work of reconditioning the Khanki Weir, which was in progress last year, was completed.

The canal continued to be fed on the still pond system of regulation except that the silt ejector tunnels functioned throughout the summer.

Silt conditions in the canal have shown progressive improvement. Factors responsible for this are given.

**HISTORY SHEET OF MANGLA HEADWORKS, UPPER JHELM CANAL, FOR THE YEAR ENDING 31ST MAY 1937.**

During the year under review the conditions remained normal and nothing of importance happened. No damage of any kind was done to the works.

**HISTORY OF RASUL HEADWORKS, LOWER JHELM CANAL, FOR THE YEAR 1936-37.**

Contains notes on monsoons and floods, damage to works, change of course of Jhelum river and measures taken to remedy this, and the principal works carried out.



**HISTORY OF TAJEWALA HEADWORKS, WESTERN JUMNA  
CANAL, FOR 1936-37.**

Contains information on rainfall, floods, canal closures, changes in the course of the river Jumna, and works carried out during the year.

*Forest Department.*

**DASTAN JANGAL.**

A pamphlet in Urdu in which the beneficial effects of forests are set forth in the form of a dialogue between a school master and his pupils.

*Department of Agriculture.*

NOTES, VOL. XVI.

*No. 2, October 1937.*

This publication is issued twice a year, in April and October, by the Punjab Agricultural Department and is intended to convey to the agriculturists in a simple form useful information and advice on agricultural matters. It is published in English and Urdu and contains brief notes on subjects of interest to agriculturists. The present issue contains the following notes amongst others :—

1. The agricultural year 1936-37 in brief review by the Director of Agriculture, Punjab.
2. The Imperial Agricultural Research Institute, New Delhi by Dr. W. Burns, Agricultural Expert, Imperial Council of Agricultural Research.
3. Soil fertility and the necessity of rotations.
4. The best rotation for cotton.
5. Some common birds injurious to cultivators.
6. Cultivation of American cotton in Punjab Canal Colonies.
7. Manuring of sugarcane.
8. Seasonal hints for planting new gardens.
9. A low lift pump suitable for Punjab conditions.
10. Influence of depth of sowing, soil and season on the germination of cotton seed.
11. Cross 591 as the best wheat variety under irrigated conditions.
12. Amelioration of sandy soils.

The publication also contains a list of leaflets issued by the Punjab Agricultural Department, list of books recommended dealing with agriculture, seed agencies in the Punjab, and price list of various agricultural implements.

*Punjab Engineering Congress.***MINUTES OF PROCEEDINGS OF THE PUNJAB ENGINEERING CONGRESS, VOL. XXV, 1937.**

Contains the following papers with discussions :—

<b>WATERLOGGING ON THE UPPER CHENAB CANAL, ITS CAUSES AND CURE.</b>	<b>B. N. Singh.</b>
<b>AGRICULTURAL ECONOMIES WITH SPECIAL REFERENCE TO IRRIGATION PROBLEMS IN THE PUNJAB.</b>	<b>Roberts.</b>
<b>THE RAISING OF JHELM BRIDGE.</b>	<b>McIntyre.</b>
<b>THE ROADS TO KULU.</b>	<b>Johnston.</b>
<b>TURBULENT FLOW IN CHANNELS.</b>	<b>Blench.</b>
<b>A NOTE ON THE BUILDING OF TWO REINFORCED CONCRETE BOX CULVERTS ON N. W. R.</b>	<b>Kumar.</b>
<b>SOME NOTES ON GUNITE AND ITS USES ON CERTAIN WORKS ON THE NORTH WESTERN RAILWAY.</b>	<b>Kumar.</b>
<b>THE DEG DIVERSION AND THE COMBINED HEAD FALL AND AQUEDUCT.</b>	<b>Kapur.</b>
<b>THE REGULATION GAUGE FOR HEADLESS CANAL METERS.</b>	<b>Wilson.</b>
<b>QUETTA RECONSTRUCTION PROGRESS, 1935-36.</b>	<b>Boddington.</b>
<b>EXPERIMENTS OF PREMIX WORK IN MILE 35, G. T. ROAD.</b>	<b>Murari Lal.</b>

For notes on individual papers see Quarterly Bulletin No. 5, pages 121-125.

**BOMBAY.***Bombay Engineering Congress.***MINUTES OF PROCEEDINGS OF THE BOMBAY ENGINEERING CONGRESS, 1937. VOL. 26.**

The following papers are included :—

<b>THE PATALGANGA R. C. C. BRIDGE AT KHARPADA.</b>	<b>Sardesai.</b>
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This is a reinforced concrete bridge of 9 spans consisting of three central bowstring girder spans of 100 ft. flanked by three reinforced concrete beam and slab spans of 48 ft. on either side. A feature of the bridge is the bowstring girder spans which are of a type patented by Messrs. Christiani and Neilson of Copenhagen. Each span is covered by two bowstring girders with reinforced concrete arch ribs and tie beams with plain 2½" steel bars as hangers.

The hangars are not vertical but inclined. Three different types of foundations have been used for the piers and abutments, namely, open, cylindrical, and well foundations. The cylindrical foundations are of reinforced concrete cylinders 5" thick and were sunk on artificial islands made of earth and moorum in the river bed at the sites of piers. This paper gives a brief history of the project, describes the characteristics of the river and considerations leading to the selection of the present site, catchment areas and discharges, loads for design, general design and construction operations. The construction operations are described in detail giving information about supply and quality of materials, pumping and other plant used and foundation construction of piers and abutments. Problems which cropped up during construction and methods adopted to solve them are described.

See also under "Civil Engineering and Public Works Review" of October 1937.

#### LIME AND CEMENT MORTARS AND THE COST OF "STRENGTH".

Graham-Smith.

This paper is the result of an enquiry as to the comparative strengths of lime and cement mortars. The enquirer desired to know if figures were available showing the strength in compression and tension of mortars composed of lime and sand in the usual proportions and of weak mixes of cement and sand, in order to decide whether lime or cement should be used on small works in out of the way places. A series of tests with the available local materials were carried out and the results are given herein. The tests include comparative tests with various mixes of cement-sand and lime-sand mortars, namely, 1 of lime to  $1\frac{1}{2}$ , 2,  $2\frac{1}{2}$  and 3 of sand and 1 of cement to 5, 6, 7, 8, 9, 10 of sand. Subsequently the tests with cement mortars were extended to ratios of 1 cement to 22 sand. Tests were also made on some cement-lime-sand mortars. The materials used and the test procedure are described. Results are given in tabular form. Some general conclusions drawn are :—

1. The rich mix lime mortar is inferior to the lean mix as regards strength.
2. The strength depends on the quantity of water used and not on the amount of lime.
3. The rich cement mortars are very much stronger than the lean ones but even 1 : 22 mortar is stronger than any of the lime mortars.
4. The replacement of cement in a 1 : 2 mortar by an equal quantity of lime resulted in an increase in strength of the mortar.

**EARTHQUAKE AND DESIGN OF STRUCTURES.**

Kynnersley.

The occurrence of several severe earthquakes in India during recent years calls attention to the necessity of studying earthquake phenomena with a view to avoid the appalling tragedies of the past. The author discusses general causes of earthquakes, seismic conditions and zones in India, manifestations and interesting features of earthquakes, and measurement of earthquake intensities. He then passes on to the design and planning of buildings of the earthquake-resistant type. General considerations for selecting sites for towns in localities subject to earthquakes are discussed. Planning of buildings, and the proper type of foundations are described. An ideal foundation is a reinforced concrete mat. For foundations on soft ground a special type of foundations known as the Salvus foundation is recommended. The salient features of this type of foundation are described and illustrated. General principles of superstructure design are mentioned. The superstructure may either be flexible or rigid, though the majority of engineers now favour the latter type. Reinforced concrete walls are the most reliable construction for earthquake proof buildings. For floors, reinforced concrete is virtually a necessity. Roof structures should be light, and tiled roofs should be prohibited. Recommendations and general instructions for other structural parts such as doors and windows, staircases, etc., are given. A brief note on building materials used in the construction of earthquake proof buildings, and extracts from building codes concerning such buildings in force in different countries are given.

**SIND.***Public Works Department (Irrigation).*

INDUS RIVER COMMISSION RECORDS, 1935-36. VOL.

II, PART I—RIVER COURSE PLANS.

INDUS RIVER COMMISSION RECORDS, 1936-37. VOL.

II, PART I—RIVER COURSE PLANS.

REPORT ON EXPERIMENTS WITH A MODEL OF A REGULATOR OVER 28TH MILE BEGARI CANAL, CARRIED OUT IN THE DEVELOPMENT AND RESEARCH DIVISION AT THE KARACHI TESTING STATION. Technical Paper No. 2, 1937.

Bushby.

Hiranandani.

The model experiments described herein were undertaken to determine the best and cheapest mode of dealing with scour below regulators. In this particular regulator which was originally a road bridge and later converted to a regulator, a scour hole 23 ft. deep was formed. A model 1/24 full size was constructed and

tests were carried out with needles and wales, and with vertical screw gates. Eighty four experiments were performed with various types of structures for preventing scour. The final design adopted consisted of 3 rows of staggered blocks mounted on baffles, and a deflector. The conclusions drawn are :—

1. The optimum height of staggered blocks mounted on baffles required to give satisfactory results without producing scour was  $1/5$  depth of water on the downstream.
2. Friction blocks used in the Punjab did not give satisfactory results.
3. An overlap of  $\frac{1}{2}$ " on either side of the blocks (equivalent to 1 ft. on the prototype), mounted on baffles, which created 3 cisterns above the pavement, were effective in reducing bed velocities.

**NOTE ON THE POSITION IN THE BARRAGE COMMAND AS WELL AS BEGARI AND SHIKARPUR INVESTIGATED AREAS IN REGARD TO CHANGES IN THE LEVELS OF OF THE SUB-SOIL WATER TABLE WHICH HAVE TAKEN PLACE BETWEEN APRIL 1936 AND APRIL 1937.**

Plans showing Hydro-Isobaths and difference contours for the whole of the Barrage Command, the Khairpur State, and Shikarpur and Begari areas are included and causes of the rise or fall of water table as indicated by the plans are discussed.

**SIND RIGHT BANK DRAINAGE PROJECT, VOL. I :  
GENERAL REPORT ON THE PROPOSED DRAINAGE  
PROJECT FOR THE RIGHT BANK.**

This drainage project has been prepared for the tract on the right bank of the River Indus in Sind bounded by the North Western Canal and the Khirtar Branch on the north, the Indus River in the east and the Khirtar Range on the west. A very large part of this area has a high subsoil water table and the principal cultivation is rice. In view of the danger of serious permanent rise in the water table in this area after the commencement of barrage irrigation the present drainage project was prepared. This report describes important features of the right bank tract, investigations leading to the preparation of the project, general features of the project, methods of fixing alignments of drains and feeders, design of drains, and design of masonry works. Plans and estimates of the works are also included. Certain conclusions arrived at as a result of field and other investigations are given. The most important of these is that there does not appear to be any necessity of taking up the construction of drainage works on a large scale in view of the general satisfactory condition of subsoil water table at the present time. The limitations of the drainage project are discussed. The strict control of irrigation supplies will obviate the necessity of construction of drainage works on a large scale.

**MEMORANDUM OF INSTRUCTIONS FOR THE RIVER  
DISCHARGE OBSERVERS IN SIND, 1936. (Second  
Edition).**

Detailed instructions are given for selecting the site at which discharge should be measured, use of the discharge boat equipment, use and care of current meters (Gurley and Haskell), use of mason's level, etc. Correct method of computing discharge is described. Instructions regarding silt observations are also included.

**WEEKLY STATEMENTS SHOWING RABI CULTIVATION  
AREAS UP TO 4TH DECEMBER 1937 IN SIND AS  
COMPARED WITH THOSE OBTAINED UP TO THE COR-  
RESPONDING DATE LAST YEAR.**

**MADRAS.**

*Department of Agriculture.*

**THE EARTH SCOPE. Leaflet No. 78.**

Charley.

Describes an implement for the levelling of fields, excavation or cleaning out of drains and channels, and in general for any job involving the movement of soil over short distances. It is operated by bullocks. The method of its use, rate of working and prices are given.

**PREPARATION OF TURMERIC FOR MARKET. Leaflet  
No. 80.**

Charley.

A new polishing machine for turmeric is described herein.

**INDIAN STATES.**

*Mysore State.*

*Department of Agriculture.*

**ADMINISTRATION REPORT OF THE AGRICULTURAL  
DEPARTMENT FOR 1935-36 WITH THE GOVERNMENT  
REVIEW THEREON.**

Contains the reports of the Director and Assistant Directors in charge of the various circles on the work carried out and reports of Experts in charge of the various sections, chemical, mycological, entomological, etc. Reports on certain important farms are also included.

## BURMA.

*Department of Agriculture.*REPORT ON THE OPERATIONS OF THE DEPARTMENT  
OF AGRICULTURE, BURMA, FOR THE YEAR ENDED  
THE 31ST MARCH 1937.

Contains a summary of the work done during the year followed by detailed reports of officers in charge of various sections and circles. Rice research is under a separate officer and investigations on rice include :—

- (1) Investigations of the effect of soil and climatic conditions on quality of rice.
- (2) Investigations of effects of different dates of harvesting on the quality of rice.

## AFRICA.

*British East African Meteorological Service.*

BULLETINS OF DAILY RAINFALL IN TANGANYIKA  
TERRITORY FOR THE MONTHS OF JANUARY TO  
DECEMBER 1936.

SUMMARY OF RAINFALL IN TANGANYIKA TERRITORY  
FOR THE YEAR 1936.

BULLETINS OF DAILY RAINFALL IN UGANDA PRO-  
TECTORATE FOR THE MONTHS OF JANUARY TO  
DECEMBER 1936.

SUMMARY OF RAINFALL IN UGANDA PROTECTORATE  
FOR THE YEAR 1936.

BULLETINS OF DAILY RAINFALL IN KENYA COLONY  
FOR THE MONTHS OF JANUARY TO DECEMBER  
1936.

SUMMARY OF RAINFALL IN KENYA COLONY FOR THE  
YEAR 1936.

## UNITED STATES OF AMERICA.

*Department of Agriculture.*

FLOW OF WATER IN DRAINAGE CHANNELS: THE  
RESULTS OF EXPERIMENTS TO DETERMINE THE  
ROUGHNESS COEFFICIENT IN KUTTER'S FORMULA.  
Technical Bulletin No. 129, November 1929.

Ramser.

Kutter's formula is generally accepted by engineers as being the most satisfactory formula in use for computing the flow of water in open channels. The results obtained by the use of this formula

are however affected to such a degree by the coefficient of roughness that the selection of the correct value for this factor is a matter of the highest importance. The series of experiments described and summarized in this bulletin were undertaken for the purpose of determining appropriate values of the coefficient of roughness for various conditions of channel. The experiments were conducted on existing channels in nine different localities. Field measurement procedure comprising the measurement of discharge, water surface slope, and cross sections is described and the method of computing the value of  $n$  is explained. The nine sets of experiments are described in detail and results are presented in tabulated form. The results of each experiment are discussed in some detail and conclusions arrived at from a study of the results are set forth at the end. A table is also given showing recommended values of  $n$  for various types of channels to be used for designing purposes.

*Department of the Interior, Bureau of Reclamation.*

**DETERMINATION OF NON-LINEAR STRESS DISTRIBUTION IN BOULDER DAM BY RUBBER SLAB EXPERIMENTS.** Technical Memorandum No. 442, March 4, 1935.

Waldorf.

This publication describes experimental investigations of stresses in the Boulder Dam by what is called the method of analogy. In this method a rubber slab of the same profile as the section of the dam to be investigated, reduced to an appropriate scale, is deflected artificially to a particular shape. Stresses in the original structure are then analogous to curvatures in the rubber slab. The method is based on the fact that the equation governing the distribution of stress in the two dimensional case has the same form as the equation governing the reflections of a rubber model, both being differential equations of the fourth order. Any system of curvatures and twists made possible in a rubber slab by deformation of the boundary will therefore be analogous to a distribution of stress in a plane solid of the same shape distorted by loads applied to the edge. To solve a plane stress problem by means of a rubber slab it is sufficient to apply to the boundary of the slab similar in shape to the original, curvatures proportional at every point of the boundary to the loading on the original. The sections, investigated are the crown cantilever section, and the horizontal arch section at elevation 900 of the Boulder Dam. A detailed mathematical discussion of the theory of the problem with mathematical computations necessary for the experiments, is given, followed by a description of the equipment used in the investigations and the general procedure of the tests. Results of the tests are discussed and the conclusions arrived at are as follows. The tests show that the rubber slab method gives reasonable results as compared to other methods and is a valuable auxiliary in rapidly determining stresses in small areas



or at check points. The results of the tests show that a linear distribution of stress exists throughout the greater part of the cantilever.

**CALCULATION OF STRESS DATA FROM STRAIN MEASUREMENTS.** Technical Memorandum No. 542, December 14, 1936.

Bergman.

This report explains a method for computing the surface stresses in a body subjected to two or three dimensional stress, from strain gauge readings taken on three or more intersecting gauge lines. The method was developed in connection with the analysis of tests of models of Boulder Dam made by the Bureau of Reclamation in the Civil Engineering Laboratories of the University of Colorado.

**NOMOGRAPHIC DETERMINATION OF BOUNDARY STRESSES IN GRAVITY DAMS.** Technical Memorandum No. 547, March 15, 1937.

Soehrens.  
Moody.  
Brahtz.

A series of thirteen diagrams are presented herein, each of which is a graphical representation of a stress formula or combination of formulas. Diagrams 1 to 5 give the maximum and minimum stresses that can occur on the faces for various loading conditions which include the action of the dead load, water load, uplift, horizontal earthquake of intensity of one-tenth gravity and vertical earthquake of intensity of one-tenth gravity. Diagrams 6, 7 and 8 give the magnitudes of dead load, water load and horizontal and vertical earthquake effect individually. Diagram 9 gives the stresses produced by a parabolic water load surcharge developed during an earthquake. Diagrams 10, 11, 12 and 13 give the effects of a change in water surface and crest conditions in general. The application and use of the diagrams are demonstrated by working out a typical example for each one. A resume of stress formulas used in preparing the diagrams is given. The magnitudes of the principal stresses alone and parallel to the faces of a gravity dam furnish a measure of its stability in a manner satisfactory for preliminary design. With the use of the diagrams a section can be obtained which upon later detailed analysis will be found to fit specified requirements closely.

**ANALYSIS OF A CIRCULAR ARCH UNDER UNIFORM LOAD.** Technical Memorandum No. 550, April 29, 1937.

Houck.

The purpose of this memorandum is to develop equations for the radial deflection at the crown due to uniform radial load, and radial

deflection at the crown due to temperature of an arch of uniform thickness with radial abutments. The forces and moments due to elastic yield of the abutments are also considered. From the equations derived curves for constants occurring therein have been plotted and provide a rapid and simple means of determining radial deflexions at the crown.

PROCEDURE FOR MAKING TEMPERATURE STUDIES ON  
EXPOSED SLABS. Technical Memorandum No.  
551, May 7, 1937.

Culver.

This publication presents a few formulæ and curves concerned with temperature variations in a concrete structure and explains their use in practice. Methods for making temperature studies on exposed slabs are given, and an explanation is given as to which methods should be used to solve a specific problem. Data to be collected and tabulated for temperature studies, are given for general and specific cases. Formulæ and calculations are given for finding the temperature at the centre of a block of concrete a given period after the placing thereof, temperature gradient across a block of concrete, isotherms for a number of blocks, time temperature curve, time required for a structure to lose a certain percentage of heat of setting, and the ratio of concrete temperature to exterior temperature.

A STUDY OF THE DETERIORATION OF RIGID METAL  
ELECTRICAL CONDUIT WHEN EXPOSED TO 100  
PERCENT HUMID ATMOSPHERE. Technical Memo-  
randum No. 554, May 17, 1937.

Bourne.  
Davis.

Results of investigations on the behaviour of rigid metal electrical conduits exposed to the corrosive effects of moist air and curing water which has been in contact with green concrete, are presented herein. Short sample lengths of half inch conduits of steel and aluminium were tested with one month's and one year's exposure, and the results are summarized.

DESIGN DATA FOR GALLERY STRESSES AS DETER-  
MINED BY MEANS OF PLASTER-CELITE MODELS.  
Technical Memorandum No. 555, June 16, 1937.

Russell.

"Steel reinforcing around galleries in dams has heretofore been designed using empirical methods to determine the stresses. The purpose of this memorandum is to show the actual stresses present in the region around a standard gallery section and to present the data so that a quick approximate solution for any ordinary loading is readily available. The problem is solved by experimental analysis for 24 different conditions of loading, and the results which include surface, tangential and principal stresses are shown as graphical stress curves".

This memorandum is a condensed summary of a report entitled "Gallery stresses as determined by means of plaster-celite models" by the writer. From the data obtained in the tests with plaster-celite models, a number of curves and charts have been prepared for the solution of stress problems around galleries. These are presented and their use is explained.

DESIGN OF ROLLER GATES. Technical Memorandum  
No. 562, October 14, 1937.

Vetter.

This memorandum gives a description of the so-called roller gate, and outlines the principles of design of such gates. Basic principles of hydrodynamics and analytical mechanics on which the design is based are discussed and detailed methods of design developed therefrom are set forth. Examples illustrating the use of the formulæ derived are given. The methods were developed for the design of the 75 ft. roller gates of the All American Canal Headworks, and the proposed 110 ft. roller gates for the Roza Dam, Yakima Project. Illustrations of the gates of the All American Canal Headworks and a diagram showing variation of reactions of the gate are given.

#### LIST OF TECHNICAL MEMORANDA.

A list showing the titles and prices of technical memoranda issued by the United States Bureau of Reclamation, numbering 543. They deal with engineering problems met with in the work of the Bureau of Reclamation.

#### TENTATIVE FIELD INSTRUCTIONS FOR LOCATING EMBANKMENT MATERIALS AND FOR CONTROLLING EMBANKMENT PLACING OPERATIONS. July 15, 1936.

These instructions outline a tentative procedure for locating embankment materials and for controlling embankment placing operations in the field so as to obtain a stable impermeable embankment. General characteristics of material suitable for rolled embankment construction are briefly discussed. Preliminary investigations necessary before construction are described. These include prospecting for borrow pits, detailed investigations of borrow pit areas, sampling of borrow pit material, and laboratory tests of materials from test pits. The points to be taken care of for control of work during construction are described, and the general procedure to be followed for embankment work is given. General notes for embankment inspection and miscellaneous information for the guidance of earthwork inspectors are given. Detailed descriptions of field tests which include manner of obtaining and submitting samples, field density test, procedure of obtaining an despatching undisturbed soil samples, compaction test, and determining moisture content in the embankment before rolling, are also given.

PREVENTION OF SCOUR AND ENERGY DISSIPATION.  
Translated by Mr. Edward F. Wilsey from pages  
78 to 173 of *Kolkabwehr und Stauraumverlandung*.

Schoklitsch.

Schoklitsch's work on the prevention of scour and energy dissipation is considered to be the most complete from the engineering standpoint. His ideas and the comprehensive data collected by him from experimental research in the laboratory on models of dams and other structures are presented in this work. In addition to his own experimental work he has made detailed references to the work of other investigators and has mentioned the results and conclusions arrived at by them. Observations at actual works are also referred to, and actual works designed on the basis of model experiments are mentioned.

The author commences with a preliminary discussion of surface, ground, and bed rollers and their energy dissipating action. Numerous investigators have studied the effect of rollers on energy dissipation and some of them have obtained conflicting results. The author states that according to model tests the efficiency of a roller depends on its form, and the more the roller approaches a circular form, the less effective it is. The subject of energy dissipation is then dealt with under two heads: firstly for flows carrying silt and secondly for flows free of silt. Special structures for scour prevention are used if the discharges through the structures carry silt. The energy dissipation is carried out in subsidiary structures. The types of flow existing downstream of a dam and the corresponding scour are described, and the process by which scour is produced is explained. Model experiments of the scouring process at dams with a free overfall, dams with aprons sloping downstream, and dams with horizontal aprons were carried out by the author, and the results are discussed. Measurements of actual scour at a number of dams of the above types have been made for several years and these are diagrammatically depicted. Results from experiments on the study of scour upstream of dams and scour measurements on the upstream of some actual dams are given. The author then proceeds to discuss various methods for reducing the scour below dams. The effectiveness of the various methods discussed was investigated by model tests and the results obtained are mentioned. These methods include a long downstream apron, a rising apron solid sills, dentated sills as originated by Rehbock, double sills, riprap placed below a solid apron, floating and shelf aprons, and check sills (walls placed downstream from the dam). Experimental results of the action of the above devices are graphically shown.

The author then passes on to energy dissipators when the flow is free of silt. These include steps or cascades, the hydraulic jump, baffle

piers, stilling pools, nozzle dissipators, spiral eddy dissipators, pipe and flume dissipators, and other miscellaneous types of dissipators. Stilling pools are dealt with in some detail and rules for their design are given. Other devices and their action are briefly described and examples of actual works of the type that have been constructed are given. Formulæ for hydraulic jump calculations are also discussed.

**THE MEASUREMENT OF VELOCITY AND PRESSURE IN THREE-DIMENSIONAL FLOW.** Translated by Mr. Edward F. Wilsey from "Zeitschrift für Flugtechnik und Motorluftschiffahrt", Vol. 23, No. 13, July 14, 1932.

Krisam.

An instrument for measuring the magnitude and direction of the velocity of flow and the hydraulic pressure in three dimensional flow, known as Zijnen's five hole pitot sphere, is described in this publication. Its use in practice and experience obtained in its application to practical problems are described.

*National Bureau of Standards.*

**FLOW IN EARTHEN CANALS OF COMPOUND CROSS-SECTION.** Translated and abstracted by Chilton A. Wright from "Annales des Ponts et Chaussées, Memoires et Documents", Vol. 106, No. 5, May 1936.

Hegly.

In order to improve traffic on the Rhine in a certain reach, a canal along the bank was proposed as an alternative to changing the river channel itself. This canal was proposed to be of a compound trapezoidal cross section. The total width would be 420 feet, divided equally into depths of 13 ft. and 33 ft. Navigation could then proceed upstream on the shallow part of the section against a velocity of approximately 2.5 ft. per sec. as compared to the maximum velocity of about 15 ft. per sec. in the river. There being no existing information on the hydraulic characteristics of a canal with this cross-section, a series of model experiments were undertaken to study the velocity distribution and the division of discharge between the two parts of the cross-section, considerations of similitude between models with different scales, water surface profiles, roughness coefficients, an effect of curvature. These experiments are described in this publication, the results are discussed and the conclusions recorded. The experiments were carried out on three models, two straight ones of 1/20 and 1/50 scale size of the actual canal and a curved one of 1/50 scale. The third one was used to study effect of curvature. The experimental procedure is described and results are tabulated.

**INVESTIGATION OF FLOW OVER WEIRS.** Translated by  
Mr. H. N. Eaton from "Mitteilungen des Hydraulischen Instituts der Technischen Hochschule  
Munchen", Heft 7, 1933.

Dillmann.

When weirs are used for the measurement of flow of water in a channel, the channel in which the weir is placed is not always sufficiently long. In such cases special stilling devices such as gratings or screens are provided upstream of the weir to obtain a uniform flow in the approach channel, a condition which is postulated in the usual formulæ for weir coefficients. These stilling devices however impress certain characteristics on the flow and therefore it is found that the usual weir formulæ are not applicable. A series of tests were undertaken to investigate the effect of various forms of stilling devices on the discharge. The tests are described herein and results obtained are represented graphically and discussed.

**CURRENT HYDRAULIC LABORATORY RESEARCH IN THE  
UNITED STATES.** Bulletin V-2, July 1, 1937.

The publication contains the following information :—

1. A list of current projects in the hydraulic laboratories of U. S. A.  
This includes studies on the following :—

Hydraulic turbines. .

Flow conditions in open channels. Laminar and turbulent flow.  
Flow around bends. Velocity distribution in stream channels. Roughness coefficient. Duration curves. Back-water curves. Hydraulic jump in a trapezoidal channel, sloping aprons and channels, enclosed conduits. Submerged flow. Sub-surface flow. Flow through weirs. Mechanics of suspended bed-load transportation. Measuring rate of flow in steep channels carrying suspended load. Flow phenomena at intersection and at critical depths of streams.

Flow in pipes.

Sand and gravel sampler and sample splitters.

Hot wire velocity meter for use in water. Metering flumes. Venturi flumes. Rating of flumes for measuring debris-laden streamflow. Current meters.

River model studies. Model of estuary of Columbia river.

Locks.

Model studies of dams, spillways, cofferdams, outlet works.

Broad-crested weirs. Short-crested circular and rectangular weirs.

Similarity of moveable-bed river models. Studies on fixed bed river models.

Characteristics of sprinklers and sprinkler systems of irrigation.

Effect of depth of watertable upon the loss of water from soil surface. Movement of moisture through soils. Flow through granular materials.

Seepage from dams. Co-efficient of soil permeability. Saturation line.

Evaporation from free water, soil, and plant.

Hydraulic performance of canal drop.

Surface run-off.

Flood hydrographs.

Ground water profiles.

Flood control reservoirs.

Stilling pools and other devices.

Locks. Gates.

Stability of sand dams.

Concrete mattress studies.

## 2. Hydraulic Research in France.

Non-permanent regime in a rectangular channel of constant slope is one of the problems under study.

## 3. Hydraulic Research in Canada.

Hydraulic model studies of different spillway profiles and calibration of a sharp-crested triangular weir are the subjects under study.

## 4. List of completed projects. These include :—

Similarity of broad-crested weirs.

Similarity of moveable-bed models.

Flood waves.

Flow conditions at intersecting streams.

Flow conditions at critical depth.

Submerged short-crested weirs.

Sedimentation basins.

Cofferdam design.

All-American Canal—"Influent Slot".

Outlet works and spillway design of Bull Lake Dam.

Needle valve, ring-follower cylinder-follower gate characteristic.

## 5. List of various hydraulic research committees with subject under investigation.

6. Foreign pamphlets received by the Bureau of Standards.

7. Translations of engineering articles prepared by various institutions in U. S. A.

*University of California.*

THE DIGESTIBILITY OF BROWN ALFALFA HAY, SESAME  
MEAL, AND ARTICHOKE SILAGE AS DETERMINED FOR  
RUMINANTS. Bulletin No. 575, May 1934.

Folger

*University of Iowa.*

THE TRANSPORTATION OF DETRITUS BY FLOWING  
WATER-II.

Mavis.

Liu.

Soucek.

This bulletin reports results of tests carried out in a flume on the transportation of bed load by flowing water. A 32 ft. long wooden flume 32 inches wide and 16 inches high was used and six samples of granular material ranging from 1.4 to 4.4 m.m. mean diameter were used as bed materials. Observations were taken for a wide range of conditions, and roughness factors in Manning's formula were determined for each test. Data obtained from more than 400 tests are analysed and empirical formulæ are derived for rates of bed load movement in terms of bottom velocity and tractive force. Details of the apparatus, materials and experimental procedure are given. Data obtained are plotted in a number of graphs and some formulæ are derived to fit the data.

*Louisiana State University, Agricultural Experiment Station.*

CHANGES IN THE OXIDATION-REDUCTION EQUILIBRIUM  
IN SOILS AS RELATED TO THE PHYSICAL PROPERTIES  
OF THE SOIL AND THE GROWTH OF RICE. Bulletin  
No. 271, January 1936.

Sturgis.

Observations made during the past 5 years in studies on the fertility problems of the soils of the Lower Mississippi flood plain and the soils of the coastal prairies show that as a result of waterlogging due to naturally poor drainage and long continued irrigation, deflocculation and other poor physical conditions are developed and reduced products which are toxic to crops are accumulated. The effects of irrigation or waterlogging on the intensity and products of reduction, and their relation to the physical properties of the soil have not been previously determined. The object of the investigations described in this bulletin was to determine the effect of waterlogging and organic matter on the rate, intensity and amount of reduction, to study the effect of irrigation on the decrease in permeability and aeration, and to ascertain the effects of certain treatments on the improvement of the physical properties of the soils. After a brief historical review of work done by previous investigators, the author goes on to describe the experimental materials and methods



used by him. The experimental results are then given and discussed in detail, and methods for improving the permeability of deflocculated soils and increasing the yield of rice on such soils are suggested. The application of leguminous organic matter was found to increase the yield of rice in a deflocculated soil. The use of commercial fertilizers without the addition of organic matter was not effective. Conclusions are given.

*Ohio State University, Engineering Experiment Station.*

**HIGHWAY SUBSOIL INVESTIGATION IN OHIO : PRELIMINARY REPORT.** Bulletin No. 39.

Eno.

This bulletin presents a brief résumé of the results obtained from highway subsoil investigation in Ohio carried out under the direction of Professor Eno of the Ohio State University. Information has been collected from observations in the field, laboratory experiments, and from the work of other investigators. General conclusions are given with regard to the occurrence of road failures, vertical displacement of pavements, frost action, moisture content of soils, subbases and subbase treatment, capillary moisture and soil characteristics. Recommendations for guidance in practice are given and soil tests made in the laboratory are described. The behaviour of porous subbase soils and the effect of various admixtures on them is discussed.

**RUNOFF FORMULAS AND METHODS APPLIED TO SELECTED OHIO STREAMS.** Bulletin No. 49.

Prior.

Formulae for computing annual run-off from rainfall are mostly empirical. The purpose of the study reported in this bulletin is to determine the accuracy that may be expected with the use of some of these formulae in the case of certain selected Ohio streams upon which accurate stream flow records exist for at least a period of ten years. Computations of run-off are made from the most widely used formulae and the results are checked with actual measured run-off. The author has also proposed modifications to increase the accuracy of the formulae. The formulae and methods tested by the author are : Myer's method ; line formulae of the type  $F=aR-B$  where  $F$  is annual run-off,  $R$  the annual rainfall, and  $a$  and  $B$  are constants ; the adjusted rainfall method ; formula proposed by Vermuele ; Justin's formula ; and Grunsky's formula. Results obtained from each of the above methods are discussed and conclusions are recorded.

**EFFECT OF CALCIUM CHLORIDE AS AN ADMIXTURE IN PORTLAND CEMENT CONCRETE.** Bulletin No. 61.

Sloane.  
McCaughy.  
Foster.  
Shreve.

This bulletin reports experimental investigations undertaken to study the effect of calcium chloride admixture on the rate of hydration

of Portland Cement and its constituent minerals, to ascertain the character of the hydration products when the Portland Cement is set up in calcium chloride solution, to determine the difference in change in moisture content between plain concrete and calcium chloride concrete during the curing period, and to determine the difference in volumetric changes between plain concrete and calcium chloride concrete during the curing period. The methods used in the tests are described and the results are discussed. Conclusions are given.

**SOME EFFECTS OF SOIL, WATER, AND CLIMATE UPON  
THE CONSTRUCTION, LIFE, AND MAINTENANCE OF  
HIGHWAYS. Bulletin No. 85.**

Eno.

Certain highway investigations carried out jointly by the Engineering Experiment Station of the Ohio State University and the Ohio State Highway Department are reported in this bulletin. The investigations deal with subgrade treatment beneath concrete pavements, and bituminous and other types of roads, subdrainage of highways, and the treatment of special soil conditions such as marshes, peat bogs, earthslips, etc. A general discussion of soil characteristics and soil tests is given and some general conclusions from the investigations for practical guidance are stated.

**THE FLOW OF WATER THROUGH ORIFICES. Bulletin  
No. 89.**

Beitler.

Results of experiments to determine the variation of discharge coefficient of sharp edged concentric orifices with pipe size, edge roundness, diameter ratio, edge thickness, and differential head, are reported in this bulletin. Several different sizes of orifice plates were tested in seven different sized pipe lines. The apparatus used is described and details of orifice plates and pipe lines used are given. The procedure of taking observations is explained and results obtained are discussed and tabulated.

**THE PREDETERMINATION OF PILING REQUIREMENTS  
FOR BRIDGE FOUNDATIONS. Bulletin No. 90**

Taylor.  
Morris.

Burkey.

Designing and construction engineers have long felt the need for a quick, accurate, and inexpensive method for determining piling requirements under the footings of the smaller bridges and structures before starting construction. With the possible exception of the method of driving test piles, the existing methods of testing a proposed bridge site to determine piling requirements are unsatisfactory. As a result of theoretical and practical investigations by the authors, two machines have been devised

with the help of which the probable behaviour of piles can be predicted. These machines are described and their use is explained. Results of tests with the machines at a number of bridge sites are presented together with their interpretation, and these are compared with actual conditions obtained after construction. A brief discussion of the theory of piling is also included.

THE PLASTIC FLOW OF CONCRETE. Bulletin No. 91.

Shank.

The term "plastic flow" is used to indicate that property of a material which is evidenced by the continuance for an appreciable time of a varying increase of deformation or strain under sustained load, or decrease of stress during sustained strain. The object of this bulletin is to assemble existing data from tests and investigations on the subject of plastic flow, to correlate them and to develop from them general principles and expressions for the use of the engineer. The data analysed are from investigations at the University of California, the Bureau of Building Research in England, and the Ohio State University. The tests at the three institutions are briefly described and results of the tests are discussed. The data from the tests are tabulated and equations for plastic flow obtained from the data are analyzed. Deductions made from a study of the data are set forth.

In order to solve plastic flow problems in structures a number of theoretical expressions and procedures are developed for columns and beams of concrete and reinforced concrete. A number of tests were made to verify the accuracy of the theoretical expressions developed in the publication, and satisfactory results were obtained.

SOIL SURVEYS FOR HIGHWAYS : Engineering Experiment Station Circular No. 33, Engineering Series, Vol. V, No. 4, July 1936.

Eno.

Preliminary studies and tests of the soil on which a highway is to be built form a recognized practice at the present time which has grown up within the last fifteen years. This circular reviews briefly the status of soil surveys as part of road construction plans in the various States, and gives a brief history of the development of road soil studies in the U. S. A. It is mentioned that notes on the sampling, testing, and field control of soils for road construction have been prepared at the Bureau of Tests, Ohio Department of Highways, and are representative of the best in current soil practice. Some salient features of these notes are described. Important soil research work carried out by various investigators is briefly described and includes the works of Dr. Terzaghi, Dr. Casagrande and others.

**ENGINEERING EXPERIMENT STATION NEWS :** Vol. IX,  
No. 4, October 1937.

This is a bi-monthly publication containing short notes on engineering matters of interest to Ohio State. One of the articles in this issue entitled " Typical stream flow records " gives a graphical representation of stream flow records of certain Ohio streams for the year 1937. The graphs show rainfall and run-off by months from October 1936 to June 1937 as recorded at a number of stations selected in three different drainage basins. Features of the graph are briefly discussed.

**THE USEFULNESS OF MATHEMATICS TO ENGINEERS.**  
Circular No. 27.

Ott.

The usefulness of the different branches of Mathematics to the engineer, namely Arithmetic, Algebra, Geometry, Trigonometry, Analytical Geometry, Calculus, Differential equations, etc., is briefly described.

*(Translations of Italian papers received from United States of America and since returned).*

**A STUDY OF THE RELATIONSHIP BETWEEN THE PRIMING HEADS OF MODELS AND OF THE PROTOTYPE OF A SELF PRIMING SIPHON.** (Translated from the Italian by the United States Bureau of Reclamation).

Veronese.

The priming head of self priming siphons is defined as the difference of elevation between the overflow sill and the water level in the forebay at which the siphon is completely primed, or the head that is created by complete vacuum in the siphon throat. The experimental researches described herein were carried out to find the relationship between the priming head of a model syphon and the priming head of the prototype. The experiments were performed with three-syphons of different types and for each type of syphon three different scale models were used. The three types of syphons and the models used are described. The procedure of carrying out the experiments is explained and results are discussed. An important conclusion arrived at from the results is that a general law relating the priming heads of the model and prototype does not exist, and the only way to determine the value of priming head for a syphon is to build and experiment on at least three models of different scales of the same type of syphon. Factors which influence the priming head are discussed and the various aspects of the problem are dealt with mathematically with a view to discover laws generally applicable.

**EXPERIMENTAL INVESTIGATIONS ON SELF-LEVELLING  
SIPHONS.** (Translated from the Italian by the United  
States Bureau of Reclamation).

Drioli.

“ The experiments described constitute, for the first time, a practically complete investigation of the different regimes of efflux of auto-leveilling syphon through direct experimentation on constructed works.”

The experimental scheme is described and results are discussed and dealt with mathematically. The results are also compared with results of laboratory experiments and it is concluded that the agreement between the two is fully satisfactory. The experiments are interpreted physically and hydraulically and it is shown that the agreement between the deductions from a normal hydraulic calculation and the resulting experimental demonstrations is very good.

**EXPERIMENTAL RESEARCH ON AUTO-LEVELLING SIPHONS :  
SECOND REPORT.** (Translated from the Italian by the  
United States Bureau of Reclamation).

Marchetti.

“ In a preliminary report there have been published and illustrated the results of a first elaboration of a series of many experiments on models of auto-leveilling syphons instituted in the laboratory of hydraulics and hydraulic constructions in the Royal School of Engineering at Pisa.....In order however that the results and conclusions may have a more general character, it has been deemed opportune to make at the same time a general synthesis of all the results of the experiments hitherto completed both under natural conditions and in the testing laboratories, on auto-leveilling syphons..... In the present note only the findings will be given that relate to the distribution of the pressure along the pipe from the intake to the outlet, the values of the pressures being deduced by piezometers applied ta successive points along the waist of the pipe.”

The experiments carried out at Pisa which were not discussed in the preliminary report are illustrated herein, and tests made in other laboratories are reviewed. The question of the comparability of models and prototypes is considered.

**ON EQUATIONS OF UNIFORM FLOW OF STREAMS : MEAN  
RADIUS AND FORM OF SECTION AS DERIVED FROM  
EXPERIMENTAL INVESTIGATIONS.** (Translated from  
the Italian by the United States National Bureau of  
Standards).

Gentilini.

“ The phenomena of the uniform flow of fluid currents lack a general and complete analytical representation ” states the author in his introductory note. The object of this paper is to summarize the experimental investigations thus far made on this question and to set forth the present position. Considering the greater

paractical importance of turbulent flow than laminar flow, the study given in the paper relates principally to the co-ordination of experimental results obtained with the former. The author briefly reviews the progress of knowledge on the uniform flow of fluids up to the present time and discusses the various formulæ developed, including the more recent conceptions of viscosity and roughness as affecting flow. He analyses laminar flow in conduits and develops a number of relations concerning such flow which are discussed in some detail. He passes on to uniform flow in smooth conduits with turbulent regime which is treated in the same manner. He then briefly summarises the experimental work on the subject by various authorities in chronological order and discusses the results in each case. The experimental investigations include those of Schiller, Winkel, Davies, White, Cornish, Nikuradse, Lea, and Lorenz. The experimental results on smooth conduits are discussed and summarized in tabular form. Finally, the effect of the form of the section on uniform flow in conduits with rough walls is discussed.

#### AUSTRALIA.

##### REPORT OF THE MELBOURNE AND METROPOLITAN BOARD OF WORKS FOR THE YEAR ENDED 30TH JUNE 1936.

##### REPORT OF THE MELBOURNE AND METROPOLITAN BOARD OF WORKS FOR THE YEAR ENDED 30TH JUNE 1937.

Contains general report on the administration, financial results, and reports on water supply and sewerage works with details of new works undertaken. Statement of accounts and balance sheet are also given.

##### REPORT OF THE RIVER MURRAY COMMISSION FOR THE YEAR 1936-37.

Report of the proceedings of the River Murray Commission for the year 1936-37 with financial statements and details of works carried out during the year. The most important work completed was the Hume Reservoir which was opened on November 21, 1936. Amongst other works, Yarrawonga weir construction was continued. Experiments with models of energy dissipators for this weir were completed and the type of dissipator finally adopted took the form of a dentated sill downstream of the structure.

##### IRRIGATION WATERS OF THE BURDEKIN DELTA. Bureau of Sugar Experiment Stations, Brisbane, Technical Communications No. 1, 1937.

Cassidy.

The Lower Burdekin area (Queensland) consists of a uniformly flat country typical of a river delta. The outstanding feature of this region is the facility with which large quantities of water

can be obtained at shallow depths, and a prosperous cane-growing settlement in this area has been established. The soil of this area is described, the sources of the underground supply and its replenishment are discussed and results of analyses of the waters of the delta are presented. It is considered that the Ca/Na ratio is the best criterion of the quality of water for irrigation, but if much free alkali be present, the water should not be used in any case. As a result of investigations it is found that the Burdekin irrigation waters are inferior in quality which will lead to deterioration of the soil for which possible ameliorants such as sulphur, gypsum, ammonium sulphate and molasses are suggested.

#### IRRIGATION AND WATER SUPPLY DEVELOPMENT IN VICTORIA, 1937.

A brief history of water conservation in Victoria is given. A number of schemes constructed and administered by local trusts were the early features of irrigation activities but most of them failed and in 1905 the State Rivers and Water Supply Commission was established. The duties and powers of the Commission are set forth and the irrigation systems administered by the Commission are briefly described. The progress in irrigation under the Commission is reviewed. Flood control is also dealt with by the Commission and the flood control works administered are described. The waters of the Murray River are administered by the River Murray Commission consisting of representatives of the States of New South Wales, Victoria and South Australia and of the Government of the Commonwealth. The Hume Dam has been constructed under the Murray Agreement and the Yarrawonga weir is under construction. The State Rivers and Water Supply Commission of Victoria are carrying out investigations of erosion conditions in the catchments of the rivers.

#### TASMANIA.

#### REPORT OF THE HYDRO-ELECTRIC COMMISSION FOR 1935-36.

Contains general report, financial summary, and report on operating conditions of the Hydro-electric Department of Tasmania.

#### INTERNATIONAL CONFERENCES, ETC.

##### *International Association for Hydraulic Structures Research.*

##### REGISTER OF THE MEMBERS, Sept. 1936.

##### CURRENT WORKS IN HYDRAULIC STRUCTURES RESEARCH. (Bulletin No. 1— July 1, 1937).

This Bulletin contains short descriptions of researches in hydraulics carried out in various laboratories in Germany, England,

Australia, Belgium, France, Canada, Hungary, Italy, Switzerland and Czechoslovakia. The object of the bulletin is not to be a collection of reports on the finished works but merely an enumeration of the work so that interested persons may know in which laboratories researches concerning certain problems have been or are being dealt with. Similar reports for researches carried out in U. S. A. and U. S. S. R. are published in bulletins of the National Bureau of Standards, Washington, and of the U. S. S. R. Commission for Exchange of Hydraulic Laboratories Research Results, Leningrad. Reports of researches in England and Canada only are given in English and include the following :—

*The Whitworth Engineering Laboratories of the Victoria University of Manchester.*

(Director Prof. Gibson). Researches carried out are :—

1. Concerning silt and salinity of the River Severn.
2. The design of piers for a bridge or sluice dam.
3. Experiments\* with a model sluice gate of the tilting flap design.
4. Streamline and turbulent flow in open channel.
5. Experiments on flow of water through smooth rectangular passages.
6. Study of laminar motion through rectangular passages.
7. Experiments on a scale model of the river Mersey to investigate viscosity effect, rate of propagation of flood waves, effect of eliminating bends by cutoffs.
8. Experiments on transportation of bed materials by flowing water.
9. Experimental investigation on the effect of bridge piers and other obstructions on tidal levels in an estuary.
- (10) Calibration of weirs of irregular section.

*Division of Mechanical Engineering, National Research Council of Canada, Ottawa.*

Research was carried out in a moving stream for use in the design of emergency dams.

The following are the summaries of some of the Reports for the First Meeting of the Association held in Berlin in October 1937.

*Programme No. 6—*

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|--|----------|
| (a) APPARATUS FOR THE MEASUREMENT OF THE SOLD MATERIAL CARRIED ALONG ON THE BEDS OF STREAMS. (Summaries in French and German). | Smetana. |
| (b) NOTE ON THE FORM OF THE FIXED CREST OF A MOVABLE DAM. (Summaries in French and German).                                    | Smetana. |



- (c) SIMILITUDE OF HYDRODYNAMIC PHENOMENA  
WHEN WATER IS CONSIDERABLY MIXED  
WITH AIR. (Summaries in French and  
German).

Smetana.

*Programme No. 8—*

- MEASURING OF MOORING STRESSES IN LOCKS IN  
THE LABORATORY AND IN NATURE. (Sum-  
maries in English, German and French).

Schijf.

*Programme No. 12—*

- OBSERVATIONS AND ANALYSIS OF THE SUSPENDED  
LOAD OF RIVERS. (Summaries in Eng-  
lish and German).

Straub.

Extensive observations and studies were made of the suspended load of the Missouri river system. The technique of the investigations is described herein. General conclusions drawn from the investigations are set forth. Observations show that the concentration of silt in a river cross-section varies from point to point both vertically and laterally. Ordinarily the amount of silt per unit volume of water is greater near the bottom than near the surface. The variation in concentration transversely across the stream was not so pronounced, as the variation from the surface to the bottom. A heavy precipitation following a drought usually results in an abnormally high silt concentration in the water. Using the data from precise measurements to determine the distribution of silt in the river, various curves were drawn to serve as a starting point for a mathematical treatment for the rate of discharge of suspended matter. By mathematical deduction it was found that the mean silt concentration factor by which the water discharge must be multiplied to obtain the silt discharge was closely approximated by taking the sum of 0.4 of the silt concentration at 0.8 depth and 0.6 of the silt concentration at 0.2 depth. As regards mechanical composition of the suspended load, several interesting results were obtained. It was found that for the finer particles the viscosity as well as density of the fluid comes into consideration and the sedimentation is governed by Stokes Law. The finer particles were quite uniformly distributed throughout the river cross-section regardless of variation in turbulence. The coarser particles follow Newton's law in sedimentation and were mostly concentrated in the lower part of the river. It was found possible to establish silt discharge rating curves for large rivers which would give reasonable values of the suspended load as related to water discharge over long periods of time. For smaller streams the relation of silt discharge to water discharge was not as well defined as for large streams.

*Programme No. 17—*

EXPERIMENTAL INVESTIGATION OF VARIOUS TYPES  
OF SELF-PRIMING SYPHONS USING SCALE MODELS.  
(Summaries in English, German and French).

Bonnet.  
Blockmans.  
Lamoën.

*Programme No. 32—*

CONTRIBUTION TO THE QUESTION OF SUB-TERRANEAN  
EROSION IN SANDY SOILS. (Summary in German).

Bernatzik.

*Permanent International Association of Navigation Congresses.*

*Bulletin No. 24—July 1937.*

This bulletin contains a report of the proceedings of a meeting of the Permanent International Association of Navigation Congresses held in Brussels on June 8, 1937. It includes the annual report of the Executive Bureau for the year ending 15th May 1937 dealing with financial and administrative matters, a verbatim report of the meeting held on June 8, 1937 in Brussels, and an account of the excursion in Germany arranged for the members of the Commission on the occasion of the meeting. The excursion included an inspection of the rivers Rhine, Main and Danube and the Nickar canalisation works.

Abstracts of the following papers are included in the Bulletin :—

HAS FLOOD CONTROL CHANGED THE HUNGARIAN  
CLIMATE ?

Rethley.

For notes see page 37 of Quarterly Bulletin No. 4.

MOLES HAVING VERTICAL SIDES.

Mendonça.

The author gives a summary of theoretical considerations upon which calculations for the design of vertical moles are based. He clearly sets forth the movements of the liquid particles in the case of undulatory movements and presents a graphical representation of the movements. He gives an analysis of the propagation of waves and discusses standing waves caused by the backwater of propagation waves from a vertical wall. Details of calculations for a vertical mole are given and tests on reduced scale models are referred to.

STABILITY OF EARTHEN DAMS UNDER THE ACTION OF  
CONSTANT OR VARYING PRESSURE.

Smrček.

In connection with the regularization of the Waag river in Czechoslovakia for the development of agriculture, navigation, and power for industrial purposes, a plan was drawn up which required the construction of canals with earthen embankments and earthen dams on the river. To determine precisely the stability of such structures a number of experiments on scalar models were carried out by the author in the Hydraulic Laboratory of the Bruun

Technical Faculty. These tests are described in detail in this paper. The tests were made with models of dykes built of different earth materials as below :—

Dyke made of gravel without any foundations.

Gravel dyke on a foundation of gravel and loess soil from the Waag Valley.

Dyke with loess core and foundation.

Gravel dyke with a loess core without any foundation, materials saturated with moisture.

The investigations were mainly directed to the determination of the behaviour of the material in the dyke under the action of upward pressures and to trace the movements of the seepage water in the body of the dyke for various upstream loads of water. A number of diagrams showing pressure lines and seepage flow lines in the models tested are given.

Experiments were also made for verification of the laws of similitude in models and prototypes. Details of these experiments are not given but conclusions derived are recorded.

For flood embankments along the river Waag study was made on models of the manner in which flood water penetrates into the embankments, the speed of the seepage, the shape of the lines of seepage flow and dis-aggregation of the embankment in case of prolonged floods.

Results of the experiments are discussed in each case and the conclusions drawn are given.

*International Society of Sugarcane Technologists.*

#### PROCEEDINGS OF FIFTH CONGRESS, BRISBANE, 1935.

This volume contains a report of the fifth Congress of the Society held in Brisbane from 27th August 1935 to 3rd September 1935. Three delegates from British India attended the Congress including Rao Bahadur Venkataraman, Government Sugarcane Expert, Imperial Sugarcane Station, Coimbatore. Details of the official opening ceremony including addresses by the Governor of Queensland and the General Chairman are given. Papers presented before sectional meetings of the Society under the following sections are given : Agricultural Section, Pathological and Entomological Section, Cane Breeding Section, and Manufacturing Section. The papers number over 90 amongst which are the following :—

1. Importance of virus diseases of sugarcane—by Brandes and Matz.
2. Symposium on the methods of maturity determination in sugarcane.
3. Cane trash and soil organic matter by Stieglitz.

4. Progress of sugarcane root rot studies in Hawaii—by Carpenter.
5. Frost damage in cane and some experiments to minimise its intensity—by Barton.
6. Symposium on the methods of seedling selection.
7. Biological control of sugarcane pests in the British West Indies and British Guiana—by Myers.
8. Irrigation in the Lower Burdekin district—by Tapiolas.  
*See also under "Publications of Australia".*
9. Drainage methods in Fiji—by Clarke.
10. Surface drainage in the Mackay district—by Clarkson.
11. Disease resistance tests on sugarcane seedlings—by Rands, Abbott, and Summers.
12. Report of Committee on Soils.
13. Report of Committee on Labour Saving Devices.
14. Rapid field tests for soil fertility—by Steiglitz.
15. A brief review of some important contributions on soils and fertilizer investigations—by Schreiner and Deemer.
16. Methods to determine fertilizer requirements of sugarcane in Louisiana—by O'Neal and Hurst.

#### OTHER PUBLICATIONS.

**THE USE OF SLAG CEMENT FOR THE CONSTRUCTION OF LARGE DAMS.** (In French). (Extract from "Science et Industrie", edition "Travaux", July and August 1937). Langavant.

This paper commences with a short history of dam construction from the point of view of the materials used, and then deals with the properties required of special cements used in the construction of large dams. The author then describes in detail the hydraulic properties of slag from blast furnaces, and the cements prepared from it, and mentions several dams which have been constructed with this material. An appendix contains comments on the subject by M. Freyssinet.

**CATASTROPHIC FLOODS IN THE UNITED STATES IN MARCH 1936 AND JANUARY 1937.** (In French). Parde.

This note describes the floods in March 1936 and January 1937 in the United States of America, and gives particulars of rainfall and melting of snows to which the floods are attributed.

**THE DISASTROUS FLOODS IN MARCH 1936 AND JANUARY 1937 IN THE UNITED STATES.** (Extract from "Materiaux pour Etude des Calamites" fasc. 39, 1937.—In French). Prade.

This paper deals with the heavy floods experienced in America in March 1936 and January-February 1937. From a study of the rainfall figures in the various catchments, and flood levels at various

gauging stations in the rivers, conclusions are reached as to the causes of the floods. The data are compared with previous record floods in the same basins. The paper concludes with a brief description of the proposed protective works, which are mostly the construction of storage reservoirs for retardation of flood water.

**THIRD TECHNICAL REPORT OF THE NATIONAL SOCIETY OF  
THE RHONE. 1937. (In French.)**

Aubert.

This is the third technical report of the Company, and it deals with the general development and improvement of the river Rhone in France, and its canal systems. The first chapter deals with hydro-electric development, and discusses the investigations in hand for ascertaining the power available. Chapter two deals with navigation, and details of river training, and their study by the use of models are given. This chapter also deals with the management and development of the inland port of Lyon.

**BORDEAUX AND THE GIRONDIN ESTUARY. (In French.)**

Leveque.

This publication contains a detailed description of the Girondin estuary in France and the adjoining sea-coast. It describes the geological formation of the coast line and traces the history of the action of the sea upon it. The estuary is compared with other similar ones in Europe. The transportation of solids by the river and formation of the delta is discussed, with notes on the action of prevailing winds. Details are given of the construction of a deep channel through the estuary by dredging, and they include useful information on the design of dredgers. The second part of the publication contains annexures dealing with dredgers and pumps, depth sounding apparatus, and the port of Verdon, with particulars of hydraulic shock absorbers provided on the quayside.

**COPY OF D. O., DATED 21ST NOVEMBER 1937 FROM  
MR. W. E. BUSHBY, SUPERINTENDING ENGINEER, EASTERN  
SIND CIRCLE TO THE SECRETARY, CENTRAL BOARD OF  
IRRIGATION REGARDING GUNITE LINING WITH HYDRAULIC  
LIME USED ON NIRA RIGHT BANK CANAL.**

Reference is made to Quarterly Bulletin No. 7, page 152 wherein an abstract of a letter from Mr. Aitken, Superintending Engineer, Deccan Irrigation Circle regarding gunite lining was published. Mr. Bushby was Executive Engineer of the Division in which the work was carried out. The lining of the approach channel on Mile 1 of the Nira Right Bank Canal and in the cutting in Mile 7 of the canal was carried out with the use of a cement gun and hydraulic lime. The lining was not constructed to stop leakage, but to reduce N so as to allow a small section to be excavated through the rock. In carrying out the work, about 2 ft. more

than the designed section was blasted out. The sides were then roughly made up with rubble, and hydraulic lime mortar was applied with a gun to fill in the interstices, and finish off the surface smoothly. Mr. Bushby believes that this is the first work in India where hydraulic lime was applied successfully with a gun in place of cement.

#### NOTE ON ASPHALT REVETMENT.

Moore.

In this note Mr. Moore describes the development of asphalt revetments for river bank protection in the United States and discusses the possibilities of this type of revetment for river bank protection in Bengal. Existing types of revetments used in Bengal are mentioned and costs are given. These include mass concrete paving, concrete block pitching, stone boulder pitching, dry brick pitching, wire enclosed brick mattress, and brushwood matting. Requirements of river bank protection and causes of failure of revetments are discussed. The qualities of revetment types used in Bengal are discussed. Some types of revetments used on the Mississippi are described and the development of asphalt revetment in U. S. A. is reviewed. The details of this type of revetment with method of construction and costs are given and the advantages claimed for this type are enumerated. Possibilities of introducing this type of revetment in Bengal are then discussed with particular reference to conditions in Bengal which are different from those in the U. S. A. Mr. Moore has framed an estimate for conducting preliminary experiments with reinforced mattress and ordinary asphalt paving with asphalt, filler, and sand locally available. If necessary the possibility of producing a thin asphalt lining suitable for irrigation canals could also be investigated on the same lines. Though the first cost of this revetment is high as compared with the cost of the commonly used types, the maintenance costs would be negligible and its effectiveness would be greater. A copy of the estimate is attached to the note.

#### NOTE ON SOIL PHYSICS AND SOIL WATER RELATIONSHIP.

Anand.

This note is an account of studies pursued at Oxford, and visits to experimental stations in Holland and Hungary during January and February 1937 while the author was on leave. The author attended the soil science laboratory at Oxford for 4 weeks and studied the following subjects:—

1. General soil physics, mechanical analysis, capillarity, permeability and shrinkage.
2. Colloids, particle size, flocculation, dispersion, hydration, etc.
3. Properties of clay, base exchange, difference between calcium, sodium and hydrogen clays, types of clay.
4. Clay acidity, crumb structure, black and white alkali soils.
5. Soil water relationships, field moisture, capacity, evaporation, etc.

In mechanical analysis, an international scale of particle sizes has been adopted. This scale is given and shows the diameters of particles of different soils such as clay, silt, fine sand etc. The methods of mechanical analysis are based on Stokes Law. Some conclusions from capillarity observations in the laboratory having a bearing on irrigation, agriculture and drainage are given. One of the conclusions is that films of water will not completely surround particles but will be in the interstices between them if the particles are not below ground water level. Another is that usually water level in a pipe or well in the ground is taken to be the subsoil water level, but actually the ground in the vicinity is saturated to a height a little above the level of the water in the well or pipe. Some characteristics of permeability are described. Permeability depends upon the mechanical structure of soils and great care is necessary in deep cultivation as it may alter the structure of the subsoil and make it impermeable. The imprisoned air in the soil is an important factor and explains the presence of the "dead layer" which is a comparatively dry layer separating the wet surface layer due to irrigation, etc. and the wet subsoil layer due to subsoil water. Saturated and unsaturated flow conditions due to percolation from the bed of a channel and the effect of percolation on the "dead layer" of soil are discussed. Conditions of flow in drains in permeable light soils and in heavy soils are described.

Colloids occupy an intermediate position between coarse suspensions and true solutions. General characteristics of colloids are described. Properties of clay in general and the properties of calcium, sodium and hydrogen clays are given, with their definitions. Salt movement in soils is discussed and factors governing salt movement in soils are mentioned. Soil classification according to  $p^H$  values as adopted in the Punjab is given. Phases of soil deterioration by salinity and remedial measures as adopted in Hungary and elsewhere are described. Method of determining  $p^H$  values of soils is briefly outlined. Soil water relationships in irrigation are discussed and some conclusions of practical value are set forth, *e. g.* (1) "In the initial stages of plant growth, a smaller quantity of water should be supplied as any water that goes below the root zone is practically lost to the plant". (2) "The sub-soil, owing to being under pressure, is usually more compact than the top-soil and hence has a less pore space. Thus a smaller addition of water is required to saturate it and raise the sub-soil water level. If the subsoil is fairly saturated, even a rain-fall of 1" sometimes causes a rise of 1' in sub-soil water level". (3) "The water holding capacities and water movements in soils depends greatly on the physical properties like the texture, the quantity and quality of organic matter present, etc. and the chemical composition of the soils".

"Thus it will be seen that the quantity of irrigation water required for crops will depend on a number of factors which have all to be taken into account while fixing duties and deltas, which will vary with the climate also." Finally, an account of visits to Holland and Hungary and items of interest seen in those countries is given. Reclamation from the sea as practised in Holland is described. Mention is also made of interesting experiments on plant growth and treatment of seed being carried out at Budapest University.

**THE USE OF MODELS FOR ELUCIDATING FLOW PROBLEMS**  
**—BASED ON EXPERIENCE GAINED IN CARRYING OUT**  
**MODEL EXPERIMENTS AT THE HYDRODYNAMIC**  
**RESEARCH STATION, POONA.**

Inglis.

In order to find proof or disproof of the reliability of open channel experimentation the Director of United States Waterways Experiment Station at Vicksburg issued circular letters to more than fifty laboratories and individuals engaged in hydraulic research. The replies received did not give much information pertinent to the subject and the conclusion drawn was that little or no information was available in justification of moveable bed models. No copy of the circular letter was sent to Mr. Inglis, and this paper has been written by him to supply information regarding the behaviour of various types of models used in hydraulic research, based on his own experience. The eight main types of hydraulic models used are described with examples showing why some types present little difficulty and give results suitable for immediate application whereas other types specially those relating to alluvial rivers present very great difficulties. Geometrically similar models in which parallel flow or free vortex flow are established give geometrically similar results provided they are not too small to make it possible to reproduce the boundary conditions of the prototype. In other cases similarity is not attained. Two models, namely, the crump type standing wave flume and the Gibb nodule are discussed in some detail and reasons are given as to why geometrically similar discharges were given by these models. The model of a high coefficient weir for Lake Arthur Hill at Bhandardara which is now under test at Poona is an example of a model which is geometrically similar in shape but does not give geometrically similar results. Some details of investigations with this model and the results are given. Models of channels in incoherent alluvium are then considered and the recent investigations of Mr. Gerald Lacey on regime channels as affecting model experiments are discussed. It is shown that the discharge required to establish regime increases inversely as the square of the silt factor, and therefore the coarser the silt the smaller the discharge required. Much larger discharges are required if the silt used in the model is fine. Regime models are not required for designing regime



channels because the Lacey formulae give far more accurate results than can be obtained by applying model results but they are helpful in determining silt movements. Experience at Poona shows that model silt charge is markedly different to that in the prototype. Mr. Inglis then passes on to combined erodible and rigid models and shows why such models cannot reproduce prototype conditions. Tidal models are an example of semi rigid models in which conditions are imposed, the sides, and in many cases the bed, being held against scour. Such models give valuable results if correctly designed, but the fact that conditions are imposed must not be overlooked. Rigid models are used in America for determining the effect of cut-offs on upstream water levels and they give results as to the immediate effect of water levels upstream. Models with mobile protections such as falling aprons, spurs, and pier and pavement protection give geometrically similar results of great value and have been successfully used at Poona. Meandering river models and combined rigid mobile and meandering river models present many difficulties. Two models, one of the Indus River 7 miles above and 3 miles below the Sukkur Barrage, and the other of the River Ganges 40 miles above the Hardinge Bridge and 15 miles below it which are under test at Poona are described in detail, and the difficulties presented in each case are described. To solve these difficulties experiments to determine the scale effect of various factors are separately carried out and the results are applied to the large full length models to enable them to give accurate results. The main fact which is stressed is the importance of large models which give results of highly qualitative accuracy and sometimes give quantitative accuracy.

#### IRRIGATION RESEARCH IN BOMBAY 1916—37.

A brief review of irrigation research work carried out in Bombay from its initiation in 1916 to date, is given in this note. A special irrigation Division was created and the work started with the investigation of damage caused by waterlogging, salt efflorescence or sodiumization in the Nira Left Bank Canal tract and methods of reclamation and drainage. Hydraulic research soon followed and the first model experiments were in connection with the alterations to the Head Regulator of the Nira Left Bank Canal to enable more discharge to be passed. The problem was successfully solved by adding a bellmouth upstream and expanding barrels downstream. Experiments in connection with remodelling masonry works and channels of the Nira Left Bank Canal were also successfully carried out. In 1918 the work of pumping Poona sewage for disposal by irrigation was started and the effluent experimental farm was opened. Rain and river gauging work was also handed over to the special division in 1934. In 1927 the Irrigation Development and

Research Circle was opened and at about this time hydrodynamic questions relating to the Lloyd Barrage Project began to be referred for solution by model experiments. The most important problems dealt with were:—

1. Altering the Barrage Basin to give minimum afflux during floods and to make the standing wave form just downstream of the Barrage instead of at the end of the apron.
2. Exclusion of heavy silt from right and left bank canals.
3. Design of new type of regulator fall for canals. A new type of fall known as "the proportional standing wave flume meter fall with baffle and deflector" was evolved which has since proved highly satisfactory.

In 1930 a hydraulic research laboratory was opened at Karachi for testing small models of various structures and a large number of experiments have since been carried out there, the results being published in a number of Bombay P. W. D. papers. An important investigation carried out in the Deccan was in connection with weeds in the Deccan Canals which demonstrated that weeds can be killed off by suitably timed canal closures. At the end of 1934 model experiments on a model of the river gauges and Hardinge Bridge at Sara were started at the request of the Hardinge Bridge Committee. Brief details of these experiments are given and the experiments in this connection are still in progress. A list of other experiments in progress numbering 27 in all is given. It is estimated that the saving which has been effected by research on the Lloyd Barrage and Canals Construction exceeds Rs. 60 lacs and that in the Deccan exceeds Rs. 40 lacs.

**COPY OF LETTER NO. G.-8, DATED THE 24TH MAY 1937 FROM THE EXECUTIVE ENGINEER, SOUTHERN DADU DIVISION, SIND TO THE SUPERINTENDING ENGINEER, WESTERN SIND CIRCLE, REGARDING WEEDS IN CANALS AND DRAINS.**

In reporting on his experience with the weed *Typha Elephantia* (Pan grass) the writer says that weed grows in clear, shallow and slow moving water, and that it does not grow thick in channels where there is an appreciable amount of silt or where the depth of water is over 3 ft. It is believed that the greater the velocity of water the less the growth of the weed.

As regards prevention of the weed growth, two methods are given. One is to dry the channel, plough it deep, turning over the roots, and exposing them to the sun for a few months. This will succeed only if no fresh seed enters the channel. This method has not been tried by the writer but was recommended by the

**Department of Agriculture.** The other method, which is considered to be better and cheaper, is that of broadcasting "Lari" rice (red rice generally grown in Lower Sind) just at the commencement of the hot weather and after cutting the existing weeds. Once this rice germinates (it germinates in water less than 1 ft.), it will prevent the weeds from sprouting. This method has been successfully tried.

**CATALOGUE AND PRICE LIST OF THE HASKELL CURRENT METERS AND THE RITCHIE-HASKELL DIRECTION-CURRENT METERS.**

Faber.

**HEATING AND AIR-CONDITIONING OF BUILDINGS.**

Kell.

This book deals with various methods of heating and air conditioning of different types of buildings and contains the latest data available on the subject. There are nineteen chapters of which the first fifteen are devoted to heating of buildings. The book starts with the description and definition of various terms used by the heating engineer. Some general problems in connection with heating are dealt with, such as heat required to maintain a given temperature, heat losses, temperature control, etc., and considerations affecting the choice of a heating system. Various heating systems with details of equipment and accessories are described together with various types of boilers and fuels used, methods of feeding, boiler mountings, and chimneys for boilers. Examples illustrating the method of calculating theoretical efficiency of boilers are given. Oil firing of boilers is dealt with in some detail because of its special advantages. Warming by hot water is used more extensively than any other system because of its simplicity, and three chapters are devoted to this method. Various types of hot water radiators, panels and other arrangements used are described. The piping system which connects the boiler with the heating surfaces is an important part of the equipment and is treated in great detail. Hot water supply for domestic use is next considered and various plants for hot water supply and piping systems are described. Heating and hot water supply by gas, electricity and steam heating are then discussed with regard to the comparative merits of each and brief details of the equipment and their arrangement in each case are given. Initial and running costs are also compared. Chapters 16 and 17 are devoted to air conditioning. The general considerations relating to air conditioning are reviewed and various air conditioning systems are described together with design of plants. Typical calculations for the design of an air conditioning system are given. Some air conditioning plants are described with particular reference to the principles of operation. The next chapter is devoted to a discussion of principles of refrigeration and description of some types of refrigeration plant for cooling air in buildings. The last

chapter deals with the use of waste heat from a private electricity generating plant for heating purposes.

The book contains 75 tables which are of great value to the designing engineer, and about 270 illustrations. Details of running and installation costs of various types of plants are a special feature of the book.

#### HYDRO AND AERO-DYNAMICS.

Green.

This is a text-book for advanced students of hydraulics, physics, aeronautics and mathematics and contains a mathematical treatment of the various aspects of the theory of motion of fluids and is based on lectures delivered at the Queen Mary College, University of London. There are ten chapters of which the first eight are concerned with the flow of a perfect fluid. They deal with equations of motion, continuous and discontinuous motion in two dimensions, vortex motion in two dimensions, wave motion and standing waves, motion in general, equipotential surfaces and stream lines, and flow past a sphere. The motion of a viscous fluid is considered in the last two chapters. Steady motion between fixed parallel planes, steady motion through a uniform tube, laminar flow, rotating liquid with cylindrical boundaries, motion past a sphere, the boundary layer, flow past a flat, plate Blasius's solution, turbulence, and Reynolds number are dealt with in these chapters. In each case a mathematical analysis of the problem is given and some relationships are derived which define the flow and other characteristics concerning the problem. Exercises for solution are given at the end of each chapter.

#### QUESTIONNAIRE ON HYDRO-ELECTRIC PROJECTS.

Questions framed by Mr. J. D. H. Bedford in connection with the United Provinces Hydro-electric Grid Scheme and Tube Well Irrigation Project, and replies thereto by Sir William Stampe are contained herein. The questions relate to capital and working costs, energy output, load factor, actual loads experienced, cost of production of energy, rates for tube-well irrigation, duties obtained in *kharif* and *rabi*, number of waterings in tube-well irrigation, and financial results of the schemes.

#### ENERGY THEORY OF TURBULENT FLOW OF LIQUIDS.

BLENCH.

"The object of this paper is to find by using Hamilton's principle the energy relations behind authoritative flow formulæ and thereby establish a new flow formula for rough conditions of rigid channels and pipes. Incidentally a further meaning is given to certain quantities whose exact nature is not known."

The author reviews existing flow formulæ starting from Chezy's equation to more recent developments associated with the names of

Prandtl, Nikuradse, Von Karman and others, which include the introduction of conceptions of boundary layer, boundary turbulence, roughness viscosity and mixing, velocity in relation to flow problems. Prandtl's and Manning's formulæ are discussed and their features are explained. The new formulæ for rough and smooth flow evolved by the author from energy principles are given and it is stated that they receive strong confirmation from hydraulic flow data and are derived from the same fundamental law. Flow within incoherent boundaries is next considered and the Lacey flow equations are analysed. The author then passes on to explain Hamilton's principle and the energy dissipation equation. Energy dissipation equations for rigid rough pipes and channels are derived and flow equations are obtained from them. Rough channels and pipes have the same flow equations and a study of the various relations obtained shows that Lacey's turbulence criterion  $\frac{V^3}{R}$  is a measure of the internal resistance per lb of fluid to the upward moving eddies. Flow equations for smooth pipes and channels are derived from the same energy relationships as in the case of rough ones. Lacey's flow formula and regime test formula are then studied and the physical significance of some of the concepts involved is explained. Finally, some conclusions drawn from the results of the analyses contained in the paper are set forth.

**REINFORCED BRICKWORK: A SURVEY OF ITS PRINCIPLES, PRESENT STATE OF DEVELOPMENT AND POTENTIALITIES.**

A bulletin issued by the Clay Products Technical Bureau of Great Britain.

Reinforced Brickwork is defined and the development of reinforced brickwork construction is traced. Advantages of this form of construction are described. The method of design is discussed theoretically and the method is applied to designing a beam. Other forms of structures for which reinforced brickwork may be used with advantage are mentioned and include foundation walls, chimney stacks, ceilings and floors. Notes and tables for design of reinforced brickwork beams and slabs and specifications for guidance in construction are given.

**HAMILTON—M. A. N. DIESEL ENGINES FOR IMPERIAL IRRIGATION DISTRICT AT BRAWLEY, CALIFORNIA.**  
(Reprinted from the February 1937 issue of "Diesel Progress".)

The All American Canal which is now under construction will have five hydro power plants installed along its length. A standby plant was also a part of the power development plans and a Diesel Engine plant has been installed at Brawley. This illustrated brochure describes the Diesel engines and subsidiary equipment.

**THE LAW RELATING TO ELECTRICAL ENERGY IN  
INDIA AND BURMA BEING THE INDIAN ELECTRICITY  
ACT 1910.**

Meares.

**HIGH SERVICE LOW COST ROADS.**

A pamphlet issued by Solvay Sales Corporation, New York on improving wearing qualities and lowering the cost of maintenance and construction of unpaved roads with Solvay Calcium Chloride. This material is produced in the form of small white flakes which absorb moisture from the air and dissolve themselves. The material is spread on the road surface by a special spreading equipment and provides surface binding of the road material. Details of its action and uses are given.

**DUST CONTROL AND ROAD SOIL STABILIZATION WITH  
COLUMBIA CALCIUM CHLORIDE.**

A pamphlet issued by the Columbia Alkali Corporation, Ohio, on the use of Columbia Calcium Chloride for road surface treatment of unpaved roads.

**COPPER-NICKEL ALLOYS.**

A bulletin of the International Nickel Company, New York, describing the use of "Monel" a copper nickel alloy for parts of dams, flood control works, locks, river boats, etc. Records of the performance of copper nickel alloys in various installations when they have been exposed to abrasion and corrosion are given to show the excellent qualities of the material.

**INTER-PROVINCIAL POWER DEVELOPMENT IN INDIA :  
SOME PRELIMINARY IDEAS ON THE POSSIBILITIES  
OF INTER-LINKED POWER SCHEMES FOR DIFFERENT  
PROVINCES AND STATES. MARCH 11, 1937.**

Stampe.

The object of the paper is to suggest briefly certain methods for implementing the principles which were broadly outlined in an article entitled 'Power and Progress' contributed to the *Statesman* of September 1, 1937. This article deals with the possible methods and sources of power development in India and the development of power in relation to industrial progress. In the present paper it is stated that cheap power is one of the important solutions of many of the economic problems common to all Provinces. Locally generated current in small towns must necessarily be more expensive than energy derived from a widespread grid system. One important factor which can be of mutual assistance to the development of cheap power in the three Provinces of the United Provinces, the Central Provinces and Bihar is the water resource of a neighbouring State. A case exists for the development of these resources for pumping schemes in the south eastern areas of the United Provinces. If demands from the Central Provinces and Bihar can be co-ordinated

a case can be made out for a more economical development to the advantage of all. An important aspect of the problem is the stage at which it becomes more economical to construct additional generating plant than to expand the network. This is discussed in detail with reference to experience in the United Provinces. Other questions requiring examination are the relative cost of generation by steam and water power and the relative cost of transmission over long distances and shorter systems with more generating stations. Figures of costs on the Ganges canal are given together with figures for the Uhl River scheme and Mysore scheme. Operating costs are then discussed and it is concluded that economic advantage in generation generally lies with hydro generation provided the bulk of the load is within a radius of 150 to 200 miles of the source of power. It is suggested in conclusion that Provinces concerned should investigate the most advantageous procedure for co-ordinating their power requirements, in conjunction with State authorities where necessary.

#### MAPS, BLUE PRINTS AND PHOTOGRAPHS.

##### *All-India.*

Maps showing lines of precise levelling and tidal stations. (Corrected to September 1936).

Map showing triangulation series and azimuth stations. (Corrected to September 1936).

##### *United Provinces.*

Ganges Valley State Tube-Well Irrigation Scheme—Map showing tube-well areas and main grid lines. (Plan No. 2 extracted from the Ganges Valley State Tube-Well Irrigation Scheme Report of 1936.)

##### *Punjab.*

Sketch showing geological sections of bed of river Chenab at Merala. 27th September 1937.

##### *General.*

Mr. C. C. Inglis's amended design of a canal fall. (The original design was reproduced in the last Bulletin. The amendment has been reproduced in this edition.)

Mr. A. M. R. Montagu's design of the above-mentioned fall. (Reproduced in this Bulletin).

#### NEWSPAPER CUTTINGS.

POONA RESEARCH INSTITUTE : TO BE MADE ALL-INDIA

STATION : INTERESTING EXPERIMENTS IN 1936-37.

August 8, 1937.

Gives the financial position of the Khadakvasla (near Poona) Research Station and its possibility of becoming an all-India Research Station for Irrigation and Hydrodynamics.

Also gives briefly the experiments that have been carried out at this Station during 1936-37. The experiments include problems of river training, storage reservoirs, canal falls, etc.

**VAST AREAS UNDER CANE CULTIVATION : RS. 6½ CRORES  
WORTH OF CROPS RAISED IN SARDA CANAL AREA.  
October 3, 1937.**

See page 115 of Quarterly Bulletin No. 7.

**HELPING FARMERS IN TRAVANCORE : GOVERNMENT  
PLANS. October 5, 1937.**

In replying to a deputation of the ryots the Dewan of the State said that the government of the State would prepare a comprehensive programme to combat hardships to them. This scheme would include the improvement of irrigation projects, supplementing them, and conducting a survey of the water resources.

**IRRIGATION IN TRAVANCORE : IMPROVEMENT SCHEME  
TO BE TAKEN UP. October 5, 1937.**

A general scheme for a rehabilitation of the irrigation system in South Travancore was explained by the Dewan in an interview. He said that investigation for irrigation facilities and survey of water supply resources would be immediately taken up and the government would pay particular attention to the restoration of tanks which had been assigned away and which were of considerable value as supplementary irrigation reservoirs.

**TUBEWELL IRRIGATION : PUNJAB TO UNDERTAKE  
SCHEME. October 5, 1937.**

The Punjab Government is understood to be considering a scheme of introducing tube-well irrigation in the arid south-eastern districts of the Punjab where canal irrigation cannot be arranged. The Finance Minister is visiting the tube-well scheme in the U. P. after which he will hold consultations with Punjab irrigation experts.

**MORE WATER FOR TRAVANCORE : IRRIGATION SURVEY.  
October 6, 1937.**

In addition to the remarks under the news, dated October 5, 1937 above, the Dewan dwelt on the possibilities of well irrigation worked by wind-mills.

**CURRENT TOPICS : TUBE WELLS. October 6, 1937.**

Editor's notes regarding the Punjab Government's proposal to introduce tube-well irrigation and the Finance Ministers visit to the U. P. tube-well scheme in that connection.



**DEVELOPMENT AND AGRICULTURE : NEW PORT-FOLIO  
IN THE GOVERNMENT OF INDIA : RUSSELL-WRIGHT  
RECOMMENDATIONS. October 7, 1937.**

It is stated that, in view of the large-scale plans for agricultural planning on a nation-wide scale recommended by Sir John Russell and Dr. Wright, there should be a separate department of Development and Agriculture in the Government of India. It is also stated that it is better to bring together all research and scientific departments like forestry, geology, nutrition, irrigation, etc.

**AGRICULTURE IN RUSSIA : SEVEN YEAR'S PROGRESS :  
SETTLING DOWN TO COLLECTIVISATION : SIR JOHN  
RUSSELL'S IMPRESSIONS. October 7, 1937.**

Sir John Russell's impressions gathered during his recent visit to Russia. He mentions the development in agriculture that has taken place since his first two visits in 1930 and 1934.

**THE EASTERN GRID PROJECT : SOME REFLECTIONS ON  
SIR WILLIAM STAMPE'S REPORT. October 7, 1937.**

This is an article by Prof. Bhim Chandra Chatterjee, commenting on Sir William Stampe's claim in his preliminary Report (abridged) on the Eastern Grid System that the Project has been a success. The Professor gives figures of certain other hydro-electric projects, compares them with similar figures for this system, and points out that the scheme has not been a financial success.

**AGRICULTURAL RESEARCH IN INDIA : EXTENSION OF  
COUNCIL'S ACTIVITIES : SIR JOHN RUSSELL'S RECOM-  
MENDATIONS : ESTABLISHMENT OF CROP PRODUCTION  
COMMITTEE. October 7, 1937.**

Gives Sir John Russell's recommendations regarding the lines on which improvement and enlargement in the Imperial Council of Agricultural Research's activities is necessary.

**BABU RAJENDRA PRASAD ON FLOOD PROBLEM : GOVER-  
NOR'S SUGGESTION. October 8, 1937.**

Babu Rajendra Prasad's study of this problem raises the following problems for consideration.

(1) It is true that river beds and other channels of drainage are getting reduced in their capacity.

(2) To what extent is this reduction in capacity due to (a) natural causes which have been in operation for a long time, such as the transfer of sands from the hilly regions, and (b) to sudden natural causes such as the earthquake.

(3) Has there been a general disturbance in the level of North Bihar due to earthquake or other causes ?

(4) Has there been deforestation on a scale sufficient to affect this question ?

(5) To what extent are railway embankments, roads and other private or public embankments responsible for the obstruction to a free flow and spread of rain and flood water over large areas ? He says that it is an inter-provincial question and suggests that the first step should be a joint conference of experts and others interested so that a common line of action may be evolved.

**THE EASTERN GRID. October 8, 1937.**

Editor's notes on Prof. Bhim Chandra Chatterjee's criticism of Sir William Stampe's Preliminary Report on the Eastern Grid.

**CENTRAL BOARD OF IRRIGATION : CHANGE IN NAME  
LIKELY. October 9, 1937.**

States that it is likely that at the ensuing meeting of the Central Board of Irrigation which commences on October 30 the name of the Board may be changed to " Central Board of Irrigation, Hydro-Electricity and Flood Control " as it deals with these subjects also.

**KUMAUN GRID PROJECT : PRELIMINARY INVESTIGATIONS. October 10, 1937.**

The U. P. Assembly has sanctioned the budget provision to cover the cost of an examination into the feasibility of electrifying Haldwani, Kathgodam, Bhowali, Ranikhet and Almora. Sir William Stampe and Mr. Gerald Lacey have since inspected the site of a possible power station on the Gaula Canal near Haldwani where it is understood that it will be possible to generate 400 k. w. at a cost of between Rs. 8 lakhs and 10 lakhs.

**UHL HYDRO-ELECTRIC SCHEME DEVELOPMENT PLAN :  
GRID SYSTEM TO COVER TOWNS UP TO DELHI.  
October 10, 1937.**

At present four 12,000 k. w. generators are installed in the power house at Joginder Nagar being capable of taking a peak load of 36,000 k. w. or 48,000 h. p. A further stage will be reached when the water which has already gone through the turbines at Joginder Nagar will be carried further along the spur to a place four miles away where it will be utilized through another set of turbines as it falls through a height of 1,200 ft., thereby developing another 48,000 k. w.

**UPPER REACHES OF HUGLI : SURVEY CARRIED OUT : IS  
RIVER BECOMING INLAND SEA OR LAGOON ? October  
11, 1937.**

Investigations recently made by the Zoological Survey of India in the upper reaches of the river Hughli point out that a diminishing

quantity of water at present flows down the river from Nadia the point where it separates from the main stream and that the channel of the river has gradually become very shallow resulting in very little fresh water flowing down the river at most times of the year, with the result that this part of the river has been transformed into an inland sea or lagoon.

**WORKING OF DECCAN CANALS : COMMITTEE TO ENQUIRE INTO CONDITIONS.** October 11, 1937.

It is understood that the Bombay Government propose to appoint a committee to enquire into the conditions of the working of Deccan canals, with special reference to the issue of water for ordinary crops, as distinct from sugarcane cultivation, revision of water rates, and use of tail water by hydro-electric works.

**IRRIGATION BOARD : MEETING IN DELHI FROM OCTOBER 30.** October 12, 1937.

Refers to the 8th annual meeting of the Central Board of Irrigation.

**HYDRO-ELECTRIC SCHEMES IN HYDERABAD : INDUSTRIAL ADVANCE : PROJECT TO COST RS. 65 CRORES.** October 12, 1937.

The Chief Engineer and Secretary to Nizam's Government for Capital Works, in a statement out-lined the possibilities existing in the State for the development of hydro-electric power. He gave a brief description of the several hydro-electric schemes that are to be developed in the State, numbering about ten in all. It is stated that from Godavary and Kistna rivers alone a continuous supply of 145,000 k. w. can be generated and about 70,000 from three tributaries of these rivers. The total cost of all these schemes will amount to Rs. 65 crores, and it is expected that on an average a return of 8 to 10 per cent. will be realised.

**HARNESSING THE MIGHTY VOGLA : SOVIET STARTS NEW PROJECT : GROUP OF HUGE POWER STATIONS.** October 14, 1937.

Preliminary work has begun on one of the Soviet's biggest enterprises, i.e., the construction of a group of gigantic power-stations on the Samara Bund of the Volga river. It is stated that their capacity will be 25,00,000 k. w. and their annual output of power will be about 1,40,00,000 kilowatts hours. The project provides for the erection of a dam 18 miles up the river which will raise the Volga 96 ft. The dam will form a reservoir more than 370 miles long. About 55,00,000 cubic metres of concrete will be used in its construction and from 25 to 30 million cubic metres of rock will be removed.

**THE SON CANALS OF BIHAR : THEIR CONTRIBUTION TO  
WEALTH OF PROVINCE. October 18, 1937.**

This is a Government of India Press Note. For notes see under Government of India publications.

**CENTRAL PROVINCES GAZETTE. October 21, 1937.**

Leave up to 16th of January, 1940, preparatory to retirement, is granted to Mr. H. A. Hyde, Chief Engineer, C. P. and Berar, P. W. D., with effect from the 16th of November 1937.

**MADRAS GOVERNOR AT METTUR : THE EMPIRE'S BIGGEST  
DAM INSPECTED. October 21, 1937.**

The Governor of Madras visited the Stanley Dam and the power stations. The first stage of the Mettur hydro-electric scheme, to generate 45,000 h. p. with three generating units, will be completed before the end of the year.

**U. P. TUBE-WELLS : RS. 126 LAKHS OUTLAY ON SCHEME.  
October 22, 1937.**

An official note on the U. P. Tube Well Scheme in the seven western districts of the Province where 1490 tube wells will be working next summer. The scheme commands an area of  $1\frac{1}{2}$  million acres and it is estimated that it will irrigate 625,000 acres in normal years and more than three quarters of a million acres in drought years. The capital outlay is estimated to reach 126 lakhs of rupees. The gross revenue will be Rs. 42 lakhs annually and the working expenses 33 lakhs.

**FLOOD PROBLEM IN ORISSA : CONGRESS MINISTRY CON-  
SIDERING MATTER. October 24, 1937.**

The Ministry is in correspondence with the Government of India and other Provincial Governments and it is understood the appointment of an inter-provincial board to suggest measures to check the flood water of the river Mahanadi is under contemplation.

**THE EASTERN GRID. October 26, 1937.**

Editorial note on the proposed Eastern Grid Scheme in the U. P. The scheme is to pump water at two points on the Ganges to supply canals in Allahabad and Partabgarh districts ; to irrigate areas south of Allahabad from the river Tons ; and also from the river Gumti at Sultanpur. In Benares district tube-well irrigation is possible. Generation will take place in the hills either of Rewa State or the Mirzapur district and the power will be transmitted to Allahabad for distribution.

**THE DEVELOPMENT OF WATER POWER IN TRAVANCORE :  
ELECTRICITY FROM THE HIGH HILLS : THE GREAT  
PALLIVASAL SCHEME DESCRIBED. October 29, 1937.**

Describes the scheme and the progress in its construction. The scheme was started in 1933. The present programme is for the development of 9,000 k. w. from the falls in the Mudirapuzha river which is a tributary of the Periyar. Total head available is 1,990 ft. distributed over three miles. The ultimate designed capacity of the project is 22,500 k. w.

A diversion weir with collapsible shutters will be constructed at Munnar and water from the Mudirapuzha river will be diverted through an open channel of a length of about 1,500 ft. and led into a tunnel bored through the Nagamalai ridge. The tunnel is roughly over 10,200 ft. long and 9 ft. high. It is lined with concrete and at some places gunnite. From the tunnel exit water will be led down to the power house by means of two penstock lines 7,700 ft. long. From the penstocks the water will be admitted to three pelton wheels each generating 6,000 h. p.

Distribution and transmission system is also described. Out of a total ready load of 5,000 k. w. 500 will be utilized for lift irrigation and drainage.

**JODHPUR WATER SCHEME : 60 MILE CANAL. October  
29, 1937.**

As the present water supply is insufficient, a scheme has been evolved by which the waters of an irrigation tank, known as Sumersammand, which is about 50 miles from the city but where rainfall is sufficient, will be transferred, by open channel flow, to a point within seven miles of the city. This canal will be concrete-lined and will cross the intervening river beds by means of siphons. It will be 60 miles long.

**CAUSE OF MALARIA OUTBREAK : RIVER TO BLAME.  
October 30, 1937.**

It is stated that the malarial condition in the Mymensingh district in Bengal is due to the Brahmaputra becoming useless for flushing purposes. It is therefore concluded that in the interests of sanitation the channel of the Brahmaputra with its branches should be improved.

**CHEAP POWER FOR AGRICULTURE : CROPS AND SOILS  
SURVEY : BOARD OF IRRIGATION MEETING. October  
30, 1937.**

Gives briefly the important subjects to be discussed at the annual meeting of the Central Board of Irrigation which begins on October 30. The subjects include design of weirs, design of falls, flood control, equitable distribution of irrigation water, production of cheap electric power, river training, etc.

**BUILT TO PROTECT DELHI : KARNAL'S HISTORY.** October 31, 1937.

Narrates how Karnal cantonment was constructed and how it was finally abandoned. It is stated that the cantonment was constructed after the occupation of Delhi in 1803 in order to protect Delhi. But it had to be abandoned in 1843 because the Western Jumna Canal, which in pre-British days was only a seasonal canal, had been made a perennial one by British engineers and this had turned Karnal district into a swamp, giving rise to malaria which in turn caused an extraordinary high death rate among the troops.

**NEED FOR MORE FOOD CROPS : INDIA'S PROBLEM : HOW WATER RESOURCES MAY BE DEVELOPED.** October 31, 1937.

Gives briefly the points mentioned in the note submitted by Mr. T. A. Curry, Chief Engineer, Bengal, to the Central Board of Irrigation, on the subject " Policy of Irrigation in India, with particular reference to future development and finance ". The note outlines the various methods of developing water resources, danger of premature reclamation in deltaic and tidal areas, methods of soil improvement, etc.

**TUBE-WELLS AT PANWARIA : NAWAB OF RAMPUR PERFORMS OPENING CEREMONY.** November 2, 1937.

Refers to the opening ceremony of the second series of tube wells installed as an experimental measure to further construction. The first series consists of 35 tube wells.

**COMPLETION OF U. P. TUBE-WELL SCHEME : TWO NEW POWER STATIONS OPENED BY GOVERNOR : SEVENTEEN YEARS' WORK PROVIDES CHEAP ELECTRICITY AND WATER : TRIBUTE TO SIR W. STAMPE : SUCCESSFUL USE OF SUBSOIL AND CANAL RESERVES : SMALL TOWNS AND MOFUSSIL AREA BENEFITS.** November 3, 1937.

The fifth and sixth of the series of seven canal-driven power stations at Chitaura and Salawa, provided under the Ganges grid project of 1935, were formally opened by the Governor of the United Provinces.

The main features of the whole scheme, which now has a gross output of 29,000 k. w. distributed by roughly 4,000 miles of transmission lines to some 1,600 sub-stations scattered over the eight western districts of U. P., are described. Over 40% of this output is employed for 1,490 tube-wells serving 600,000 acres.

**U. P. TUBE-WELLS : CANAL FEEDERS OPENED AT SAR-DHANA. November 3, 1937.**

The Governor of the U. P. performed the opening ceremony of 30 tube-wells, which pump roughly 100 cusecs directly into a canal. The construction of tube-wells as direct means of irrigation was not feasible in the area to be fed due to geological reasons. This additional water is being utilized mainly for irrigation on the Mat Branch.

**IRRIGATION BOARD : WATERLOGGING MENACE : FLOOD PROBLEMS : SIR W. STAMPE TO ADDRESS TO-DAY'S MEETING. November 3, 1937.**

Refers to the meeting of the Central Board of Irrigation commencing on October 30. Gives the list of officers who attended the meeting. Refers to the address to be delivered by Sir William Stampe on inter-provincial power development and gives the Board's decision regarding gauging of river discharges.

**PLEA FOR CHEAP POWER : SIR W. STAMPE ON GRID SYSTEM. November 4, 1937.**

Gives briefly the address of Sir William Stampe before the Central Board of Irrigation delivered on the subject of inter-provincial power development in India.

**POWER FROM THE GANGES. November 4, 1937.**  
Editorial notes on the Ganges Grid Scheme.

**HYACINTH PEST : OFFICIALS VISIT WORK OF CANAL RECLAMATION. November 4, 1937.**

Certain Dacca officials visited the Arial *bil* in the Munshiganj subdivision to see the working of the water hyacinth control scheme that had been inaugurated in the area from the beginning of the year.

**THE GANGES GRID : November 5, 1937.**

Editorial notes on the scheme.

**CENTRAL BOARD OF IRRIGATION : ECONOMIC PROBLEMS OF PROVINCES : CAN BE SOLVED BY CHEAP POWER : CO-ORDINATION OF NEEDS SUGGESTED : SIR WILLIAM STAMPE'S ADVICE ON DIFFERENT SYSTEMS. November 5, 1937.**

Gives Sir William Stampe's address on inter-provincial power development delivered before the Central Board of Irrigation.

**FLOOD PROBLEMS DISCUSSED : WATERLOGGING AND  
LAND RECLAMATION : CENTRAL BOARD IN SESSION.  
November 5, 1937.**

Mentions some of the subjects discussed at the meetings of the Central Board of Irrigation.

**MR. M. R. RICHARDSON ELECTED PRESIDENT FOR NEXT  
SESSION. November 5, 1937.**

Mr. M. R. Richardson, C.I.E., Chief Engineer, U. P., was elected President of the Central Board of Irrigation for the ensuing year.

**METTUR DAM NOT IN DANGER : RECENT TREMORS : N.  
INDIA EARTHQUAKES THE CAUSE. November 7,  
1937.**

See under Government of India publications.

**ELECTRIFYING TRAVANCORE : WHAT THE PALLIVASAL  
PROJECT MEANS. November 5, 1937.**

Describes briefly the project. See also news dated October 29, 1937.

**DAWN OF A NEW INDUSTRIAL AGE IN U. P. : OPENING OF  
GANGES GRID SCHEME. November 8, 1937.**

An illustrated article by Sir William Stampe describing briefly the history and main features of the scheme.

**ARTESIAN WELL : BORING EXPERIMENTS IN BHARATPUR.  
November 8, 1937.**

At Bharatpur a tube-well has been sunk which has yielded results with all the characteristics of an artesian supply. During the boring operations a stratum of clay and kankar was encountered down to 330 ft. Immediately below this came sand and gravel down to 354 ft. exactly similar to that which might be found on the bed of any river and from this surged up clear, apparently potable water to a height of 9 ft. from ground level yielding 900 gallons per hour. By means of a compressor and pump this natural flow has been increased to yield 12,000 gallons per hour. Experiments are still proceeding.

**NEW GOVERNMENT DEPARTMENTS : START OF WORK.  
ALLOCATION OF SUBJECTS : LABOUR SCOPE. Nov-  
ember 8, 1937.**

The existing Departments of Commerce and Railways, and Industries and Labour have been reshuffled and in their place have been created the Departments of Commerce, Labour and Communications. The subjects under each department are given, also the names of officers of each department. Irrigation has been placed under the department of Labour.



**LETTER TO THE EDITOR : IRRIGATION IN BENGAL.**

November 9, 1937.

This is a letter from Mr. H. B. Saxby. He says that just as tube-well irrigation has been a success in the U. P. there is every possibility of its proving equally successful in those areas of Bengal which are not being served by open canals. He says that although hydro-electric power may not be feasible, electricity on rates comparable to U. P. can be produced from coal, for the Province has abundance of coal fields.

**INDUSTRY IN GWALIOR : CULTIVATION AND IRRIGATION.**

November 10, 1937.

This is an article by Sir Kailash Narain Haksar, C.I.E., B.A. He gives in general the condition of Gwalior in respect to industry, cultivation and irrigation, and the possibilities of future development.

**FLOOD CONFERENCE IN PATNA : NEED FOR CO-OPERATION****BY ALL GOVERNMENTS : BIHAR GOVERNOR'S SPEECH.**

November 12, 1937.

The Flood Conference, convened by the Bihar Government in order to devise ways and means to tackle the flood problem and formulate a policy to deal with it, was opened by the Bihar Governor and was attended by officials, non-officials and experts of Bihar, Bengal, U. P., Nepal and Hyderabad State. The problems was discussed in all respects and the need of co-operation of the Provinces and States affected was stressed.

**INDIA'S IRRIGATION PROBLEMS : RESEARCH NEED :****DECISION OF CENTRAL BOARD. November 13, 1937.**

Gives the subjects discussed at the annual meeting of the Central Board of Irrigation. One of the subjects discussed was the necessity of a Central Research Station for Irrigation and Sir John Russell's recommendations in this respect were also examined.

**RAJEN BABU'S ADDRESS. November 14, 1937.**

Gives the gist of Babu Rajendra Prasad's address before the Flood Conference. He said the problem of floods, irrigation and malaria needed a comprehensive solution and this required scientific investigation first.

**EMBANKMENTS TO BE REMOVED : RESOLUTION PASSED****BY FLOOD CONFERENCE. November 14, 1937.**

The Flood Conference passed a resolution stating that the damage caused by floods was usually aggravated by embankments, which should be removed after an enquiry into their merits individually, and the existing waterways, roads and railways

enlarged and increased where necessary. New embankments should be constructed only in exceptional cases. The Embankment Act should be amended in order to provide constitution of a Flood Committee to advise the Government on flood problems.

**SETTLING IRRIGATION RATE : COMMITTEE TO DECIDE  
POLICY. November 14, 1937.**

It is understood the Government of Bombay have decided to appoint a Committee of four officials and five non-officials to go through the policy of the government regarding irrigation rates of water supply, etc.

**ELECTRIFICATION OF BIHAR : U. P. OFFICIAL'S EXPERIENCE  
November 15, 1937.**

Sir William Stampe may be invited by the Bihar Government to advise the government on the possibilities of extending electrification to rural areas. Sir William recently expressed the opinion that electricity could be produced cheaply from coal power in the province.

**IRRIGATION RESEARCH STATION AT POONA : FUTURE  
DISCUSSED : NEW CENTRAL INSTITUTE AT DELHI.  
November 15, 1937.**

Gives the gist of discussion of the Central Board of Irrigation on the subject of an all-India Research Station for Irrigation. The Board decided that there should be a Central Station and that it should be somewhere near Delhi, and further that it should be financed by the Government of India.

**FLOOD PROBLEM IN BIHAR : NEPAL RIVER POLICY.  
DIVERSION AT SOURCE CRITICISED. November 16,  
1937.**

Describes the suggestions and discussion put forward at the Flood Conference. One of the sources of floods was stated to be Nepal Government's Constant diversion of the flow of water from one river to another which causes heavy flooding in particular rivers.

**EXPANSION OF U. P. GRID : CHEAP POWER FOR RURAL  
AREAS : LINKING OF PROJECTS : SIR WILLIAM STAMPE  
ON FUTURE PROGRESS. November 23, 1937.**

This is a speech of Sir William Stampe at a meeting of the U. P. Centre of the Institution of Engineers, India, in which he discusses briefly the steps required for the consolidation of the electrical position in the U. P. as it stands today, and the measures that must be taken for the further development of the situation.

**NAINI TAL LAKE LEAKAGE FEARS : COMMITTEE REPORT :  
HYDRO-ELECTRIC SYSTEM NOT IN DANGER. November 25, 1937.**

A technical committee was appointed to report on the capacity of the lake to meet the demands of hydro-electric supply in view of leakage from the lake, the movement of hillsides, etc. Their report dispels any fear of the breakdown of the hydro-electric system. It is recommended by the committee that an Executive Engineer should be in single charge of the Division to give his full time for the protection of hillsides.

**CONTROL OF WATER HYACINTH : NEW BENGAL SCHEME.  
November 26, 1937.**

A new and scientific scheme for the eradication of water hyacinth has been inaugurated in the Arial *bil* in Decca district. The scheme consists in the erection of barricades. The alignment of one line of barricade is made across the direction of the prevailing wind. The masses of water hyacinth driven by high winds move towards the barricade and being obstructed in their progress are deflected into the *khals* of Ichamati and thence into the Dhaleswari and the Padma, and ultimately to the sea, to be finally destroyed there by saline water.

**ENGINEERING TRIUMPH : LLOYD BARRAGE BENEFITS :  
SIND TRANSFORMED DESERTS THAT ARE NOW " SMILING  
FIELDS ". November 26, 1937.**

See under Government of India publications.

**KARACHI CANALS DIVISION : IMPROVEMENTS IN WATER  
SUPPLY. November 26, 1937.**

An official statement on the improvements made to make good the deficiency of water caused to the Karachi Canals Division zamindars by the off-taking of water higher up in the Indus.

**GENERATING ELECTRIC POWER : FEASIBILITY OF TANDO  
MASTIKHAN FALLS. November 26, 1937.**

That Tando Mastikhan Falls, being of low head—only 10 ft.—are not serviceable for producing hydro-electricity is the view which appears to have been expressed by the Chief Electrical Adviser to the Sind Government.

**CONSTRUCTION OF WALLS AND CEILINGS : TREATED  
TIMBER BEST MATERIALS. November 26, 1937.**

Some notes on a pamphlet on the subject issued by the Forest Research Institute, Dehra Dun, claiming treated wood to be the best material for walls and ceilings.

**OFFICIAL VIEW UNDULY OPTIMISTIC : MR. GAZDAR ON  
BARRAGE SCHEME : " ESTIMATION CAN NEVER BE  
REACHED " . November 27, 1937.**

Mr. Gazdar, a member of the Reorganization Committee of the Sind Government, has submitted a note to the committee making a case for a reduction of Rs. 25 lakhs in the expenditure of the Public Works Department as he thinks that the estimated figure of 54 lakhs of acres of ultimate cultivation cannot be reached. He says that this estimation was based on the assumption of an intensity of cultivation of 81% (27 kharif and 54 rabi) but this has only been 24.09 and 10.83 respectively.

**THE JUMNA MISBEHAVES : DELHI INVITES ADVICE  
FROM POONA. November 28, 1937.**

Several years ago the Government of India established a pumping station, for irrigating the winter capital, on the right bank of the river about half a mile below the Red Fort. After flowing for many years close by this pumping station, the river has changed its course about a third of a mile away. As the water supply for New Delhi gardens depends entirely on this pumping station the government had to construct a channel from the new stream to the pumping station. They have also built three training bunds on the left bank but these bunds are interfering with several miles of training bunds constructed by the U. P. Government for diverting water towards Okhla Weir six miles below. The Poona Research Station has been asked for advice and they are now conducting model and other experiments.

**POWER FOR 12,000,000 : METTUR'S HYDRO-ELECTRIC  
DEVELOPMENT. November 28, 1937.**

First stage of the Mettur Hydro-Electric scheme has been completed. Gives in brief the features of the scheme.

**PUNJAB DRIVE FOR MORE REVENUE : INQUIRY AFOOT :  
SUGGESTIONS INVITED FROM PUBLIC. December 1,  
1937.**

The Punjab Resources and Retrenchment Committee has issued a comprehensive questionnaire inviting suggestions for means by which the revenue of the Province may be increased. Modification of the water rates is one of the questions. It is also asked if the sale of water by volume could be advocated for increasing revenue.

**REPAIRING DAMAGE : RECONDITIONING OF ANDERSON  
WEIR. December 1, 1937.**

See page 13 of Quarterly Bulletin No. 7.

**COMPLAINTS AGAINST PUBLIC WORKS DEPARTMENT :**  
**" INADEQUATE WATER SUPPLY AND UNSYMPATHETIC**  
**OFFICERS " : DR. HEMANDAS R. WADHWANI'S IN-**  
**PRESSIONS OF HIS TOUR. December 3, 1937.**

The Public Works Minister, Sind, made a tour in the Province and has collected opinions of zamindars regarding problems of seepage, widening of modules, repairs of minors, etc. He finds divergence of opinion between zamindars and officials. He will report the complaints of zamindars to the Secretary, Public Works Department for eliciting opinion of departmental staff. Then he will call a conference of zamindars and decide changes to be effected.

**BIHAR DEVELOPMENT : SIR W. STAMPE'S VISIT TO**  
**PATNA. December 4, 1937.**

Sir William Stampe is visiting Bihar to discuss the possibility of electrification in Bihar.

**TUBEWELL IRRIGATION : PUNJAB MINISTER VISITING**  
**U. P. December 5, 1937.**

The Punjab Minister in charge of the P. W. D. is visiting the U. P. tube well scheme to study its practical working with a view to introducing this system in the Punjab.

**WHERE RIVERS GO TO SCHOOL : IRRIGATION RESEARCH**  
**STATION'S PROJECTED MOVE TO DELHI. December**  
**5, 1937.**

Gives a brief description of some of the river training experiments conducted at the Poona Research Station and mentions that it has been proposed to move the Station to Delhi.

**CURRENT TOPICS : VALUE OF RESEARCH. December 5,**  
**1937.**

Emphasises the value of research by mentioning the advantages gained from certain experiments conducted at the Punjab Irrigation Research Institute and the Poona Research Station.

**RIVERS OF INDIA—No. 2 : THE GODAVARI AND ITS**  
**RELIGIOUS SIGNIFICANCE. December 5, 1937.**

Describes the Godavari river with reference to its religious sanctity.

**SIR W. STAMPE : DISCUSSING WITH BIHAR OFFICIALS.**  
**December 6, 1937.**

Sir William Stampe discussed the possibility of rural electrification with Bihar officials. Discussion was mainly confined to a general survey of the possibility of the proposed scheme which experts now believe to be practicable.

**IRRIGATION LINK : PHALTON-BARAMATI ROAD TO BE IMPROVED.** December 7, 1937.

The designs of a bridge over the Nira river, a road and drainage works for joining the irrigation tracts of the Nira Right Bank and Nira Left Bank Canals between Phalton and Sangavi, are now in hand.

**PUNJAB'S PROGRESS IN AGRICULTURE : NEEDS OF PROVINCES.** December 7, 1937.

The Second Meeting of the Crops and Soils Wing of the Board of Agriculture and Animal Husbandry in India was opened by the Punjab Governor. The agenda of the meeting included the subject of water requirements of crops in which irrigation engineers are interested.

**SPANNING THE MEGHNA.** December 8, 1937.

This is an editorial note. It is stated " the opening of the new bridge over the Meghna river marks not only the completion of a fine engineering feat but a notable development of the communications between Bengal and Assam ". The remarkable engineering feature of this structure is that the pier caissons have been sunk in 65 ft. of water, which is stated to be the greatest depth in which well sinking has been attempted in India. The bridge has been built with Indian cement, Indian steel and Indian labour.

**FLOOD RELIEF IN ORISSA ; STATEMENT OF WORK BY GOVERNMENT.** December 9, 1937.

This is a Government communiqué which gives the relief measures undertaken in connection with the floods in the Mahanadi river and its branches.

**RIVERS OF INDIA—No. 3 : THE INDUS " FATHER OF INDIAN RIVERS "** December 12, 1937.

This is an article by K. Saththianadhan. It gives a general history of the river. Mention is also made of the Sukkur Barrage Project.

**PRESIDENT " CLIMATE CONDITIONS " HIS COUNTRY : MOUNTAIN AIR FOR POLISH CABINET MEETINGS.** December 12, 1937.

Prof. Ignatius Moscicki, the present President of the Polish Republic, is also a world authority on chemical engineering. He has constructed an apparatus which produces artificial mountain air, i.e., not only cleanses the air of any given locality but supplies it with the tonic and curative qualities which make mountain air health-giving, bracing and refreshing.

**CANAL DUES : COLLECTION SYSTEM IN SON AREA CHANGED.** December 15, 1937.

A new system known as the " modified central system of collection " has been introduced as an experimental measure in four collection circles of the Son Canals in Bihar. Under this system tehsildars instead of peons go direct to the rate-payers for collection.

**NEW POWER SCHEME : MINISTER'S INSPECTION OF SITE IN TINNEVELLEY.** December 15, 1937.

The Public Works Minister, Madras Government, inspected a site for a hydro-electric reservoir in the Papanasam hills in Tinnevelly district for supplying electricity for industrial and other purposes in Tinnevelly district and adjoining areas where there are many cotton and other mills. Definite proposals have now been made and the scheme is estimated to cost Rs. 2½ crores.

**AGRICULTURAL RESEARCH IN SIND : SUB-SURFACE INVESTIGATION SCHEME.** December 16, 1937.

An important meeting of the committee appointed by the Imperial Council of Agricultural Research to work out a scheme of sub-surface investigation in the Lloyd Barrage area was held in Karachi. The committee suggested that in addition to the work already being carried out by the Sind P. W. D. the work of the estimation of clay fraction should also be undertaken. They also suggested that the work of exchangeable bases, total base saturation capacities, availability of food material and the distribution of soil colloids in different horizons of a complete soil profile should also be undertaken.

**CANAL LOSSES : U. P. IRRIGATION EXPERIMENTS.** December 17, 1937.

Gives some of the subjects on which experiments will be carried out in U. P. during the year 1937-38. For full programme of research work in the U. P. see pages 2 to 4 of the last Bulletin.

**NEW SCHEMES OF RESEARCH : GRANTS SANCTIONED : APPROVAL OF REPORTS OF BRITISH EXPERTS.** December 17, 1937.

Grant of Rs. 6 lakhs has been given for carrying out certain schemes of agricultural development and live-stock improvement as suggested by Sir John Russell and Dr. N. G. Wright.

A scheme to decide the water requirements of crops is also to be tried at Lyallpur. This scheme is not an irrigation investigation but is to determine how much water crops need in different conditions of growth.

**SOIL RESEARCH : PROGRAMME OF POONA EXPERIMENTS.**

December 21, 1937.

For full programme of research of the Irrigation Research Division, Poona, see page 4 of last Bulletin.

**SALT MOVEMENTS IN SOILS : PUNJAB RESEARCHES :****IRRIGATION INSTITUTES PROGRAMME FOR 1938.**

December 22, 1937.

For full programme of the Punjab Irrigation Research Institute see pages 5 to 11 of the last Bulletin.

**PUNJAB IRRIGATION PROBLEMS : 12 YEARS' WORK.**

December 26, 1937.

A brief review of the most important subjects investigated at the Punjab Irrigation Research Institute since its establishment in 1925.

**CENTRAL RESEARCH INSTITUTE : LAHORE'S CHANCES.**

December 30, 1937.

States Punjab Irrigation Research Institute's chances, as compared with the Poona Research Station, of being made an all-India Research Station.

**SCIENCE CONGRESS JUBILEE : VICEROY TO PRESIDE.**

December 30, 1937.

**IRRIGATION POLICY IN BOMBAY : ASSESSMENT AND****WATERLOGGING PROBLEMS. December 31, 1937.**

The Bombay Government have appointed a committee, with Sir N. Visweswaraya as Chairman, to examine the Government's irrigation policy. The terms of reference are :—

- (1) What should the general irrigation policy of the government be as regards supply of water to owner irrigators, tenant farmers and industrialised undertakings ; also in regard to the supply of water for non-agricultural purposes, *e.g.*, water for municipalities, mills, railways, etc.
- (2) If the present policy is suitable, is any revision of water rates and canal rules necessary, taking into consideration the cost of water and value of different crops ?
- (3) If any other policy is recommended, what should be the basis of assessment on account of irrigation facilities provided ?
- (4) What steps should be taken in the case of lands in villages damaged by waterlogging ?

M. T. GIBLING,

*Secretary,**Central Board of Irrigation*







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